This Abstract book is based on a compilation of all abstracts selected for oral and poster presentations, as of 15 May 2015.

Due to the inability of some authors to attend, some of those works will therefore not be presented during the conference.
Welcome to the Conference

Welcome to Paris, welcome to ‘Our Common Future under Climate Change’!

On behalf of the High Level Board, the Organizing Committee and the Scientific Committee, it is our pleasure to welcome you to Paris to the largest forum for the scientific community to come together ahead of COP21, hosted by France in December 2015 (“Paris Climat 2015”).

Building on the results of the IPCC 5th Assessment Report (AR5), this four-day conference will address key issues concerning climate change in the broader context of global change. It will offer an opportunity to discuss solutions for both mitigation and adaptation issues. The Conference also aims to contribute to a science-society dialogue, notably thanks to specific sessions with stakeholders during the event and through nearly 80 accredited side events taking place all around the world from June 1st to July 15th.

When putting together this event over the past months, we were greatly encouraged by the huge interest from the global scientific community, with more than 400 parallel sessions and 2200 abstracts submitted, eventually leading to the organization of 140 parallel sessions.

Strong support was also received from many public French, European and international institutions and organizations, allowing us to invite many keynote speakers and fund the participation of more than 120 young researchers from developing countries. Let us warmly thank all those who made this possible.

The International Scientific Committee deserves warm thanks for designing plenary and large parallel sessions as well as supervising the call for contributions and the call for sessions, as well as the merging process of more than 400 parallel sessions into 140 parallel sessions. The Organizing Committee did its best to ensure that the overall organization for the conference was relevant to the objectives and scope. The High Level Board raised the funds, engaged the scientific community to contribute and accredited side events. The Conference Secretariat worked hard to make this event happening. The Communication Advisory Board was instrumental in launching and framing our communication activities on different media. We are very grateful to all.

We very much hope that you will enjoy your stay in Paris and benefit from exciting scientific interactions, contributing to the future scientific agenda. We also hope that the conference will facilitate, encourage and develop connections between scientists and stakeholders, allowing to draw new avenues in the research agenda engaging the scientific community to elaborate, assess and monitor solutions to tackle climate change together with other major global challenges, including sustainable development goals.

Christopher Field, Chair, CFCC15 Scientific Committee
Jean Jouzel, Chair, CFCC15 High Level Board
Hervé Le Treut, Chair, CFCC15 Organizational Committee
Committees

Scientific committee

- Chris FIELD (IPCC, USA) - Chair
- Philippe CIAIS (LSCE, France)
- Wolfgang CRAMER (IMBE, France)
- Purnamita DASGUPTA (IEG, India)
- Ruth DEFRIES (Colombia University, USA)
- Navroz DUBASH (CPR, India)
- Ottmar EDENHOFER (PIK, Germany / IPCC, USA)
- Michael GRUBB (University College London, UK)
- Jean-Charles HOURCADE (CNRS- France)
- Sheila JASANOFF (Harvard Kennedy School of Government, USA)
- Kejun JIANG (Nanyang Technological University, China)
- Vladimir KATTSO (MGO, Russia)
- Hervé LE TREUT, France (CNRS-UPMC/France)
- Emilio LEBRE LA ROVERE (National University, Brazil)
- Valérie MASSON-DELMOTTE (LSCE/IPSL, France)
- Cheik MBOW (ICRAF, Kenya)
- Isabelle NIANG-DIOP (IRD, Senegal)
- Carlos NOBRE (SEPED/MCTI, Brazil)
- Karen O’BRIEN (University of Oslo, Norway)
- Joe JACQUELINE PEREIRA (University Kebangsaan, Malaysia)
- Shilong RAO (Peking University, China)
- Hans OTTO PÖRTNER (Alfred Wegener Institute, Germany)
- Monika RHEIN (University of Bremen, Germany)
- Johan ROCKSTRÖM (Stockholm University, Sweden)
- Hans Joachim SCHELLMÜLLER (PIK, Germany)
- Robert SCHÖLES (University of Witwatersrand, South Africa)
- Pete SMITH (University of Aberdeen, UK)
- Youba SOKONA (The South Centre, Switzerland)
- Jean-François SOUSSANA (INRA, France)
- Mark STAFFORD-SMITH (Future Earth, Australia)
- Thomas STOCKER (University of Bern, Switzerland)
- Laurence TUBIANA (IDDRI, France)
- Diana ÜRGE-VORSATZ (Central European University, Hungary)
- Penny URQUHART (Independent analyst, South Africa)
- Carolina VERA (University of Buenos Aires, Argentina)
- Alistair WOODWARD (University of Auckland, New Zealand)
Organizing committee

Chair:
- Hervé Le Treut (CNRS-UPMC)

Members:
- Wolfgang Cramer (CNRS/Future Earth)
- Pascale Delecluse (CNRS)
- Robert Kandel (CNRS/Ecole polytechnique)
- Frank Lecocq (AgroParis Tech/CIRED)
- Lucilla Spini (ICSU)
- Jean-François Soussana (INRA)
- Marie-Ange Theobald (UNESCO)
- Stéphanie Thiébault (CNRS)
- Sébastien Treyer (IDDRI)

Conference Secretariat:
- Claire Weill, Head (INRA)
- Géraldine Chouteau (Météo-France)
- Aglaé Jézéquel (INRA)
- Gaëlle Jotham (INRA)
- Ingrid Le Ru (IDDRI)
- Benoît Martimort-Asso (IRD)
- Nadia Mersali (IDDRI)
- Catherine Michaut (CNRS-UVSQ/IPSL)
- Aline Nehmé (INRA)
- Jeremy Zuber (INRA)
- Aimie Eliot (INRA)
- Eve Le Dem (INRA)

Communication Advisory Board:
- Richard Black, Energy and Climate Intelligence Unit
- Hunter Cutting, Climate Nexus
- Owen Gaffney, Future Earth/Stockholm Resilience Centre
- Kalee Kreider, United Nations Foundation
- Michelle Kovacevic, Communications consultant
- Jonathan Lynn, IPCC
- Kim Nicholas, Lund University
- Tim Nuthall, European Climate Foundation
- Nicholas Nuttall, UNFCC
- Roz Pidcock, Carbon Brief
- Charlotte Smith, Communications INC
- Sue Williams, UNESCO
- Denise Young, ICSU
- Jeremy Zuber (INRA)
High Level Board

- Future Earth
- Intergovernmental Panel on Climate Change (IPCC)
- International Council for Science (ICSU)
- United Nations Educational, Scientific and Cultural Organization (UNESCO)
- World Meteorological Organization (WMO)
- European Commission – Climate action
- European Investment Bank (EIB)
- The World Bank
- Ministère de l’agriculture, de l’agroalimentaire et de la forêt
- Ministère de l’écologie, du développement durable et de l’énergie
- Ministère de l’éducation nationale, de l’enseignement supérieur et de la recherche
- Ministère des affaires étrangères et du développement international
- Observatoire national sur les effets du réchauffement climatique
- Bureau de recherches géologiques et minières (BRGM)
- Centre de coopération internationale en recherche agronomique pour le développement (CIRAD)
- Centre national d’études spatiales (CNES)
- Centre national de la recherche scientifique (CNRS)
- Commissariat à l’énergie atomique et aux énergies alternatives (CEA)
- Institut de recherche en sciences et technologies pour l’environnement et l’agriculture (IRSTEA)
- Institut de recherche pour le développement (IRD)
- Institut français de recherche pour l’exploitation de la mer (IFREMER)
- Institut français des sciences et technologies des transports, de l’aménagement et des réseaux (IFSTTAR)
- Institut national de la recherche agronomique (INRA)
- Météo France
- Muséum national d’Histoire naturelle (MNHN)
- Alliance nationale de coordination de la recherche pour l’énergie (ANCRE)
- Alliance nationale de recherche pour l’environnement (AllEnVI)
- Alliance nationale des sciences humaines et sociales (Athéna)
- Alliance nationale pour les sciences de la vie et de la santé (Aviesan)
- Agence de l’environnement et de la maîtrise de l’énergie (ADEME)
- Agence française du développement (AFD)
- Agence nationale de la recherche (ANR)
- Conférence des présidents d’université (CPU)
- Université Pierre et Marie Curie (UPMC)
- Kic Climat
- Institute for Sustainable Development and International Relations (IDDRI)
- International institute for environment and development (IIED)
- Sustainable development solutions network (SDSN)
- The energy and resources institute (TERI)
- Universcience
- Ville de Paris
- Région Ile de France
Partners

With the generous patronage of

International partnerships

Major sponsors

Official partners

Participation of Southern Researchers is supported by

The Conference is grateful for the collaboration of
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1.1 - Climate variability and change over the last millennia: Paleoclimatic information and climate simulations</td>
<td>13</td>
</tr>
<tr>
<td>L1.2 - Climate Change and Land Systems: Impacts and Feedbacks</td>
<td>14</td>
</tr>
<tr>
<td>L1.3 - Climate Change and Ocean Systems: Introduction and Background</td>
<td>16</td>
</tr>
<tr>
<td>L1.4 - Climate change and health – Risks and Responses</td>
<td>17</td>
</tr>
<tr>
<td>L1.5 - Climate variability, change and vulnerability in the Pacific, Indian and Southern Oceans</td>
<td>18</td>
</tr>
<tr>
<td>L2.1 - Drivers of Change and Visions of Development: Are Climate Policy and Development Compatible Goals?</td>
<td>19</td>
</tr>
<tr>
<td>L2.2 - New pledges (INDCs) for 2025/2030: Are they reinforcing development and consistent with a 2°C pathway?</td>
<td>19</td>
</tr>
<tr>
<td>L2.3 - Climatic Variability and the Social and Human Dimensions of Vulnerability</td>
<td>21</td>
</tr>
<tr>
<td>L2.4 - Early Warning for Thresholds and Tipping Points in the Earth System</td>
<td>22</td>
</tr>
<tr>
<td>L2.5 - Food and water security under climate change</td>
<td>23</td>
</tr>
<tr>
<td>L3.2 - Transformational Energy Technologies</td>
<td>27</td>
</tr>
<tr>
<td>L3.3 - Managing Transitions in Cities: Towards resilient, low-carbon cities</td>
<td>27</td>
</tr>
<tr>
<td>L3.4 - Ecosystem–based Adaptation and Biodiversity Conservation: How we can help organisms to adapt by themselves, what the limits are, and how we can use ecosystem processes to help people adapt</td>
<td>29</td>
</tr>
<tr>
<td>L3.5 - Benefits of mitigation of climate change for coastal areas</td>
<td>30</td>
</tr>
<tr>
<td>L4.1 - The climate, finance and trade nexus: turning a political challenge into a sustainable development opportunity</td>
<td>33</td>
</tr>
<tr>
<td>L4.2 - Resilience and Transformative Solutions – Refining Old Strategies and Developing New Ones for Adaptation in Island Environments</td>
<td>34</td>
</tr>
<tr>
<td>L4.3 - Regional Perspectives on Low Carbon Pathways: exploring the conditionalities for climate resilient and equitable development</td>
<td>36</td>
</tr>
<tr>
<td>L4.4 - Multilevel Governance of Climate Change – New Strategies for Coordinating Policies on Mitigation and Adaptation</td>
<td>36</td>
</tr>
<tr>
<td>L4.5 - Equity: A Condition to Triggering Action?</td>
<td>38</td>
</tr>
<tr>
<td>1101 - From the Holocene to the Anthropocene: the history of human–environmental interactions</td>
<td>39</td>
</tr>
<tr>
<td>1102 - From past to future Climate Changes</td>
<td>43</td>
</tr>
<tr>
<td>1103 - Climate variability and external forcings of the Common Era with special focus on the role of volcanic eruptions</td>
<td>53</td>
</tr>
<tr>
<td>1104 - Climate services and information: from global change to local decisions</td>
<td>55</td>
</tr>
<tr>
<td>1105a – Assessing climate observations</td>
<td>61</td>
</tr>
<tr>
<td>1105b – Quality and availability of data for global sustainability</td>
<td>62</td>
</tr>
<tr>
<td>1106 – The Earth’s energy imbalance and exchanges at the atmosphere–ocean interface: from fundamental research to societal concern</td>
<td>72</td>
</tr>
<tr>
<td>1107 – Sea level rise and ice sheets</td>
<td>75</td>
</tr>
<tr>
<td>1108 – Middle Atmosphere influence on Climate</td>
<td>81</td>
</tr>
<tr>
<td>1109 – Understanding the Earth’s changing water cycle</td>
<td>85</td>
</tr>
<tr>
<td>1110 – Observing the changing ocean climate</td>
<td>88</td>
</tr>
<tr>
<td>1111 – Climate variability, change and vulnerability in the Pacific, Indian and Southern Oceans</td>
<td>93</td>
</tr>
<tr>
<td>1112 – The Arctic Climate system</td>
<td>99</td>
</tr>
<tr>
<td>1113 – Climate Extremes: Patterns, Mechanisms and Impacts</td>
<td>101</td>
</tr>
<tr>
<td>1114</td>
<td>Global emissions and their implications for climate targets</td>
</tr>
<tr>
<td>1115</td>
<td>GHG Monitoring</td>
</tr>
<tr>
<td>1116</td>
<td>Biogeochemical Feedbacks to Climate Change</td>
</tr>
<tr>
<td>1117</td>
<td>Understanding decadal variations in the climate system and implications for the future</td>
</tr>
<tr>
<td>1118a</td>
<td>Attribution of extreme events: How are high impact extreme events changing and why?</td>
</tr>
<tr>
<td>1118b</td>
<td>Attribution of extreme events: How are high impact extreme events changing and why?</td>
</tr>
<tr>
<td>1119a</td>
<td>Extreme hydrological events: Deciphering changes in hazard and risk at different time-scales</td>
</tr>
<tr>
<td>1119b</td>
<td>Extreme hydrological events: Deciphering changes in hazard and risk at different time-scales</td>
</tr>
<tr>
<td>1121</td>
<td>Air Pollution and Climate Change linkages and Health Impact Assessment</td>
</tr>
<tr>
<td>1122</td>
<td>Global warming hiatus</td>
</tr>
<tr>
<td>1123</td>
<td>Climate change education for sustainable development</td>
</tr>
<tr>
<td>2201</td>
<td>Between the cracks of future climate projections: exploring weather events and climate scenarios with no precedence</td>
</tr>
<tr>
<td>2202</td>
<td>Turn down the Heat: Climate Change Impacts, Development and Lock-in</td>
</tr>
<tr>
<td>2203</td>
<td>Defining dangerous climate change: Contributions from the AR5 ‘Key Risks’ and ‘Reasons for Concern’ frameworks and future directions</td>
</tr>
<tr>
<td>2204</td>
<td>A world above 2°C global warming: understanding risks and developing transformative solutions</td>
</tr>
<tr>
<td>2205</td>
<td>Multi-sectoral analysis of risks to climate change (hot spots) at 2 °C warming</td>
</tr>
<tr>
<td>2206</td>
<td>The World in 2050 – What does it look like and how do we get</td>
</tr>
<tr>
<td>2207</td>
<td>Ocean Change: Understanding and projecting the impacts of warming and acidification on natural and human systems</td>
</tr>
<tr>
<td>2208</td>
<td>Deep-sea ecosystems and climate-change: new perspectives to address knowledge gaps in impact assessment</td>
</tr>
<tr>
<td>2209</td>
<td>Transformative pathways to sustain marine ecosystems and their services under climate change</td>
</tr>
<tr>
<td>2210</td>
<td>Coastal Impacts of Climate Change</td>
</tr>
<tr>
<td>2211</td>
<td>Climate change in mountains: from impacts to resilience</td>
</tr>
<tr>
<td>2212a</td>
<td>Climate change and freshwater – 1: State of knowledge</td>
</tr>
<tr>
<td>2212b</td>
<td>Climate change and freshwater – 2: Shaping the Future</td>
</tr>
<tr>
<td>2213</td>
<td>Ecological feedbacks to climate change</td>
</tr>
<tr>
<td>2214</td>
<td>Climate-ready adaptation for conservation and ecosystem services</td>
</tr>
<tr>
<td>2215</td>
<td>Tropical degraded forests response to global change: current knowledge and cross-cutting research challenges for monitoring and processes understanding</td>
</tr>
<tr>
<td>2216</td>
<td>Climate smart forestry– Integrating mitigation and adaptation into sustainable development</td>
</tr>
<tr>
<td>2217</td>
<td>Global scenarios of land-use change and land-based mitigation, and their importance in the climate system</td>
</tr>
<tr>
<td>2218</td>
<td>Land-based mitigation: agriculture, forests, bioenergy</td>
</tr>
<tr>
<td>2219</td>
<td>Politics and numbers: Political and technical challenges in reducing emissions from forests with REDD+</td>
</tr>
<tr>
<td>2220</td>
<td>Landscape level adaptation and mitigation: integrating science, policy and practice</td>
</tr>
<tr>
<td>2222</td>
<td>Semi-Arid Regions Adaptation</td>
</tr>
<tr>
<td>2223</td>
<td>Modeling Our Agricultural Future</td>
</tr>
<tr>
<td>2224</td>
<td>Agrarian and pastoral societies: adaptive strategies and innovations</td>
</tr>
<tr>
<td>2225</td>
<td>Climate Smart Agriculture: Propaganda or Paradigm Shift?</td>
</tr>
<tr>
<td>Page</td>
<td>Title</td>
</tr>
<tr>
<td>------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>2226</td>
<td>Health and climate change: the need for a diversity of approaches</td>
</tr>
<tr>
<td>2228</td>
<td>Removing Barriers to Climate Change Mitigation at City Level</td>
</tr>
<tr>
<td>2229</td>
<td>Cities and their environments: Assessing Climate Change Impacts, Adaptation and Mitigation strategies across scales from rural to urban</td>
</tr>
<tr>
<td>2230</td>
<td>Transport and climate change: mitigation and adaptation measures for transport infrastructures</td>
</tr>
<tr>
<td>2231</td>
<td>Cultural Heritage facing up to Climate Change, Sea Level Rise and Pollution</td>
</tr>
<tr>
<td>2232</td>
<td>The Copernicus Climate Change Service: an European answer to Climate Change Challenges</td>
</tr>
<tr>
<td>2233</td>
<td>Climate Change Adaptation and Disaster Risk Reduction: International and Urban approaches</td>
</tr>
<tr>
<td>2234</td>
<td>Building Resilience to Climate and Weather Extremes: Sustainable Solutions Grounded in Socio-Cultural Context</td>
</tr>
<tr>
<td>2235</td>
<td>Reinforcing Resilience</td>
</tr>
<tr>
<td>2236</td>
<td>Scenarios, public deliberation and decisions</td>
</tr>
<tr>
<td>2237a</td>
<td>Planetary Economics (1): Costs of Inaction and Benefits of Policy Action</td>
</tr>
<tr>
<td>2237b</td>
<td>Planetary Economics (2): expanding the horizons of economic sciences and the policy implications</td>
</tr>
<tr>
<td>2238</td>
<td>Indigenous and Non-Indigenous Science in Collaboration for Our Common Future</td>
</tr>
<tr>
<td>2239</td>
<td>Co-production of knowledge: How to interact to produce climate adaptation research, between scientific communities and stakeholders, at local or international, also between North and South countries?</td>
</tr>
<tr>
<td>2240</td>
<td>Perceptions of climate change</td>
</tr>
<tr>
<td>2241</td>
<td>New representations and new frames for the climate change debate</td>
</tr>
<tr>
<td>2242</td>
<td>Migration dynamics under current and future climate change</td>
</tr>
<tr>
<td>2243</td>
<td>Multi scale adaptation and responses in vulnerable coastal sectors under climate change risks</td>
</tr>
<tr>
<td>2244</td>
<td>Climate Change Biodiversity and Human Well-Being: illustration from forests and agro-forests systems</td>
</tr>
<tr>
<td>2245</td>
<td>Modelling the complexities of the Earth System</td>
</tr>
<tr>
<td>3301</td>
<td>Climate Intervention: Evaluating its Risks, Benefits, and Potential</td>
</tr>
<tr>
<td>3302</td>
<td>Key Energy Technologies for Low Carbon Pathways</td>
</tr>
<tr>
<td>3303</td>
<td>Decarbonizing Electricity/Electricity Transition</td>
</tr>
<tr>
<td>3304</td>
<td>Climate change, carbon budgets and energy sector regulation</td>
</tr>
<tr>
<td>3305</td>
<td>Energy efficiency as a core means to decarbonize demand</td>
</tr>
<tr>
<td>3306</td>
<td>Transitioning from fossil fuels and avoiding lock-ins</td>
</tr>
<tr>
<td>3307</td>
<td>Negative emissions for climate change stabilization &amp; the role of CO2 geological storage</td>
</tr>
<tr>
<td>3308</td>
<td>Fiscal Reform</td>
</tr>
<tr>
<td>3309</td>
<td>Costs and benefits of adaptation: Lessons from developed and developing countries</td>
</tr>
<tr>
<td>3310</td>
<td>Climate finance at scale: emerging opportunities?</td>
</tr>
<tr>
<td>3311</td>
<td>Climate mitigation policies – learning, evaluating and comparing national experiences</td>
</tr>
</tbody>
</table>
3312 - Planning and assessing adaptation: Frameworks, methods and results ........................................ 495
3313 - Coordinated Adaptation to Climate Change .................................................................................. 507
3314 - Innovate for addressing climate change challenges: examples from different industries .......... 512
3315 - Energy Innovation for Climate Change: systems approaches and societal responses ............... 513
3316 - Towards solutions that transcend technology and markets: The role of choices and behaviour change.............................................................. 523
3317 - Mainstreaming low carbon consumption: challenges and opportunities .............................. 528
3318 - Sustainable strategies to mitigate climate and improve public health in developed and developing countries ........................................................................... 533
3320 - Food Systems and Food Security: Health and Environment ......................................................... 537
3321 - Health Responses ........................................................................................................................ 546
3322a - Representation of technological dynamics and societal transformation .............................. 555
3322b - Development of pathways: their mix of endogenous and exogenous uncertainties and their future under a changing climate ................................................. 556
3323 - Governance and Justice .............................................................................................................. 563
3324 - Paradigms for Building Resilience from Cross-scale Integrated Risk Governance Perspectives ...... 565
3325a - Overcoming barriers to transitions: knowledge to action and the importance of communication .................................................................................. 567
3325b - Creating the climate change groundswell by communicating business, science and regional activity .............................................................................. 568
3326 - The Mediterranean Basin in a warmer and drier world: challenges and opportunities .................. 572
3327 - Adapting to Arctic Climate Change ............................................................................................... 580
3328 - Climate Change Challenges, Adaptation Barriers and Responses ............................................... 582
3329 - How Might East African Landscapes Respond to Future Climate Change? .............................. 589
3330a - Facing climate change in Sub-Saharan Africa ............................................................................. 593
3330b - Facing climate change in Sub-Saharan Africa .............................................................................. 595
3331 - Forest landscape management to create resilience in the face of climate change in West and Central Africa .................................................................................. 624
3332 - Asia on the Frontlines: Projected Impacts, Vulnerability and Adaptation ............................................ 628
3333 - China’s climate policies and low-carbon innovation ..................................................................... 631
3335 - Climate Change Mitigation in Latin America .............................................................................. 633
3336 - Post-2030 decarbonisation pathways in Europe .......................................................................... 637
3337 - Facing floods and climate challenges: designing governance arrangements and unlocking financing on the pathway to resilient cities ................................................. 637
3338 - European Collaborative Research and Innovation for Climate Action ....................................... 641
3339 - Effective design and implementation of EU climate policy ......................................................... 642
3340 - Conflict and Climate Change ....................................................................................................... 644
3341 - Gender and Climate Change: From Vulnerability to Mainstreaming in Adaptation and Mitigation .................................................................................. 646
<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3342</td>
<td>Developing Capacity through Low Carbon Initiatives, Climate Adaptation and Increased Resilience to Climate Impacts in the Asia-Pacific Region</td>
<td>652</td>
</tr>
<tr>
<td>4401</td>
<td>Sustainable development goals and the new climate regime: synergies for change?</td>
<td>656</td>
</tr>
<tr>
<td>4402a</td>
<td>Low carbon pathways for staying below 2°C: Global requirements</td>
<td>658</td>
</tr>
<tr>
<td>4402b</td>
<td>Low carbon pathways for staying below 2°C: Global requirements</td>
<td>660</td>
</tr>
<tr>
<td>4403</td>
<td>Revising the 2015 Paris Climate Change Agreement architecture for better governance and outcomes</td>
<td>668</td>
</tr>
<tr>
<td>4404</td>
<td>Climate finance: New sources, new instruments, more effects?</td>
<td>671</td>
</tr>
<tr>
<td>4405</td>
<td>On the macroeconomic opportunity of climate policy</td>
<td>673</td>
</tr>
<tr>
<td>4406a</td>
<td>Climate, Sustainable Development and Energy Security</td>
<td>676</td>
</tr>
<tr>
<td>4406b</td>
<td>Climate change and Development: Alleviating poverty and achieving inclusive development within the constraints of a global carbon budget and other planetary boundaries</td>
<td>678</td>
</tr>
<tr>
<td>4407</td>
<td>The Challenges and Opportunities of Multilevel Adaptation Governance</td>
<td>683</td>
</tr>
<tr>
<td>4408</td>
<td>Risk and Insurance</td>
<td>687</td>
</tr>
<tr>
<td>4409a</td>
<td>The «new» climate governance: Driving societal transformations?</td>
<td>689</td>
</tr>
<tr>
<td>4409b</td>
<td>Climate Governance: New and emerging challenges after Paris</td>
<td>689</td>
</tr>
<tr>
<td>4410</td>
<td>Citizens and governments as drivers of cultural and political change</td>
<td>705</td>
</tr>
<tr>
<td>4411</td>
<td>Can the Green Economy save the climate?</td>
<td>709</td>
</tr>
<tr>
<td>4412</td>
<td>Inequalities, responsibilities and equity in global climate policy</td>
<td>713</td>
</tr>
<tr>
<td>4413a</td>
<td>Technology, transformations and capabilities in developing countries</td>
<td>719</td>
</tr>
<tr>
<td>4413b</td>
<td>Environmental policies to enable innovation and transformation</td>
<td>720</td>
</tr>
<tr>
<td>4414</td>
<td>Leveraging Multi–layered Climate Science–Policy Social Learning and Dialogue for Transformative Solutions: Towards A Proposal to “Decade for Accelerating Climate Dialogue for Action”</td>
<td>723</td>
</tr>
<tr>
<td>4415a</td>
<td>Urban policies for Accessibility, Mobility and Informal settlements in the Global South to cope with Climate Change: Emerging Issues, Innovations and Opportunities</td>
<td>734</td>
</tr>
<tr>
<td>4415b</td>
<td>Transformative solutions for urban sustainability governance: Multi–level government and cross–sectoral collaboration for efficient climate action</td>
<td>737</td>
</tr>
<tr>
<td>4417</td>
<td>Transforming Society and Science for Sustainability – Addressing Challenges in Transdisciplinary Research</td>
<td>742</td>
</tr>
<tr>
<td>4418a</td>
<td>Information for decision–making – How to engage in future thinking or plan for the long term</td>
<td>747</td>
</tr>
<tr>
<td>4418b</td>
<td>Information for decision making – Improve availability, access and use of information</td>
<td>748</td>
</tr>
<tr>
<td>4419</td>
<td>Climate science in the public sphere, Media coverage and communication devices analysis for effective policy implementation</td>
<td>763</td>
</tr>
<tr>
<td>4420a</td>
<td>How to price carbon for industry?</td>
<td>766</td>
</tr>
<tr>
<td>4420b</td>
<td>What role of carbon pricing in a post Paris world?</td>
<td>768</td>
</tr>
</tbody>
</table>
L1.1- Climate variability and change over the last millennia: Paleoclimate information and climate simulations

K-L1.1-01

Model-data comparison over the last millennium: progress, uncertainties and challenges

F. González Rouco (1)
(1) Instituto de Geociencias, Madrid, Spain

Present day climate variability and change, including recent anthropogenic warming, poses questions that cannot be answered based solely upon instrumental records. The last two millennia (L2k), and specifically the last millennium (LM), are immediate temporal intervals that involve climate processes similar to nowadays. The last 2k and LM have the potential to expand our understanding of climate variability from inter-annual and decadal to multi-centennial timescales, place a wider context for current warming and explore internally induced and externally forced responses of the climate system. Knowledge about proxy-based climate reconstructions, paleoclimate model simulations and external radiative forcing may emerge then as key elements to gain insights about the relative roles of internal versus forced variability.

Comparisons of last millennium simulations and reconstructions constitute opportunities for learning about pre-instrumental climate variability beyond the lessons that climate simulations and reconstructions efforts can offer by themselves. Model-data comparisons provide insight about the relative roles of internal variability and external natural or anthropogenic induced changes and the processes involved. The relatively short ranges of external forcing variability within the last 2k/LM nevertheless make these comparisons challenging and further complicated by the large uncertainties that affect both reconstructions and model simulations (Masson-Delmotte et al. 2013).

This work reports on the progress of about a decade of efforts in L2k/LM model-data comparison and discusses how model-data comparison exercises focused on the last millennium can improve our understanding of decadal to multi-centennial climate variability as well as contribute to our knowledge of present and future climate and/or associated projection uncertainties. For this, the model and reconstructed ensembles are compared at the available continental, hemispherical and global L2k/LM temperature reconstructions, an ensemble of simulations including both Paleoclimate Modelling Intercomparison Project Phase III (PMIP3) and Coupled Model Intercomparison Project Phase 5 (CMIP5). Taylor et al. 2012) and non-PMIP3 model experiments, as well as the external forcing configurations applied (Schmidt et al. 2012) are analysed. In addition to the simulation of external radiative forcing (TEF), including all individual forcing factors, is estimated as a simple approach to compare the total radiative forcing applied to each experiment (Fernández-Donado et al., 2013).

At hemispherical and global scales, simulations and reconstructions on the major temperature changes and suggest, despite the important influence of the internal variability, an overall linear response to external forcing above multidecadal timescales. The rate of temperature response to TEF changes in L2k/LM is quantified as a metric of the transient climate response during the LM (LMTCR) and its distribution from the model and reconstructed ensembles are compared to other estimates of climate sensitivity and transient climate response. LMTCR also allows to frame a simple quantitative comparison between simulations and reconstructions where discrepant behaviors can be singled out. The uncertainties in reconstructions and model experiments that impact our understanding of simulated and reconstruction responses at these spatial scales are also discussed.

At regional/continental scales we focus on the assessment of PMIP3/CMIP5 experiments and temperature reconstructions developed within the PAGES 2k project (PAGES 2k consortium 2013) and their responses to forcing and report on their consistency across regions and timescales. Inter-regional behavior is more homogeneous in the simulated than in the reconstructed climates. Agreement between simulations and reconstructions is higher for Northern Hemisphere regions whilst models disagree more with the reconstructions in the Southern Hemisphere.

Fernández-Donado, L. et al., 2013: Temperature response to external forcing in simulations and reconstructions of the last millennium. Climate of the Past, 9, 393–421.


K-L1.1-02

Variability of the North Atlantic Oscillation during the past millennium

V. Masson-Delmotte (1) ; P. Ortega (2) ; F. Lehner (3) ; D. Swingedouw (4) ; CC. Raible (5) ; M. Casado (6) ; P. You (7)
(1) IPSL, Paris; (2) 1LSCE/IPSL, UMR 8212 (CEA-CNRS–UVSQ), CEA Saclay, Gif-sur-Yvette, France; (3) University of Bern, Climate and environmental physics, physics institute, Bern, Switzerland; (4) Universite de Bordeaux, UMR CNRS 5805 EPOC, Pessac, France; (5) University of Bern, Climate and environmental physics, physics institute, Bern, Switzerland; (6) 1LSCE/IPSL, UMR 8212 (CEA-CNRS–UVSQ), CEA Saclay, Gif-sur-Yvette, France; (7) Laboratoire des Sciences du Climat et de l’Environnement, Saclay, France

The North Atlantic Oscillation (NAO) is the dominant mode of winter atmospheric circulation variability in the Northern Hemisphere. This atmospheric mode is characterized by a changing dipole of sea-level pressure between the Azores and Iceland, and has widespread impacts on temperature, precipitation, storm tracks and therefore on strategic sectors such as insurance, renewable energy production, crop yields and water management.

Recent developments of dynamical methods offer promising advances for seasonal NAO predictions. However, assessing potential predictability at multi-annual time scales requires a documentation of past NAO low-frequency variability. A recent bi-proxy NAO reconstruction spanning the last millennium suggests that long-lasting positive NAO conditions were established during medieval times, explaining the particularly warm conditions over Europe; however, this result is still debated. Here, we present a new annually-resolved NAO reconstruction for the last millennium based on an initial selection of 48 proxy records distributed around the Atlantic Ocean and surrounding continents and built through an ensemble of multivariate regressions. This approach has been validated in perfect model analyses, using climate simulations as physically consistent surrogates of the real world. The analysis makes evident that the multi-proxy reconstruction outperforms the bi-proxy index.

The final reconstruction shows no persistent positive NAO during the medieval period, but suggests that positive phases were dominant during the thirteenth and fourteenth
European summer hydroclimate variability during the last millennium

H. Linderholm (1) ; K. Seftigen (2) ; E. Cook (3) ; D. Chen (4) ; T. Ou (4)

(1) University of Göteborg, Institute of geography, Göteborg, Sweden; (2) Swiss Federal Research Institute WSL, Birmensdorf, Switzerland; (3) Columbia University, Lamont-doherty earth observatory, Columbia, United States of America; (4) Gothenburg University, Department of earth sciences, Gothenburg, Sweden

Associated with global warming, changes in extreme weather and climate events have been observed in Europe, including increased frequencies of heat waves as well as the frequency or intensity of heavy precipitation events. In a future warmer world, it is likely that the risk of hydroclimatological extremes will increase. Extreme hydroclimatic events, such as droughts and floods, can have significant impacts on society, e.g. by affecting food availability, water quality, health, energy, infrastructure etc., but also on ecosystems. It is apparent that climate variability and change already pose a challenge to Europe’s economic sectors, production systems, and ecosystems. Increased drought frequency will significantly affect natural and human systems, and compared to other hazards, they can persist for long periods and affect large areas. Floods, associated with heavy precipitation events, can pose threats to life and property, and also affect water quality, e.g. by spreading pollutants and fertilizers. Clearly, society must prepare for an intensification of hydroclimate extremes in the future. However, major uncertainties and knowledge gaps still exist in understanding and modeling hydroclimate, making it difficult to quantify future changes and their impacts on economic systems and sectors. A prerequisite to mitigate extreme hydroclimatic events is good understanding of their spatiotemporal characteristics as well as the mechanisms generating such events. However, the lack of instrumental observations limits the period of spatial analysis to the recent century, making it difficult to fully understand natural hydroclimate variability.

Tree rings can provide annually resolved environmental and climate information and are widely used as proxies of past climatic events, such as drought or floods. The wide geographical distribution of tree-ring chronologies, compared to most other high-resolution climate proxies, provides a potential to infer past climate change on large spatial scales. Recently, past hydroclimate variability has been reconstructed from networks of moisture-sensitive tree-ring chronologies in North America and Monsoon. These reconstructions have not only provided valuable information of past hydroclimatic characteristics, but they also have provided essential background data for increasing the understanding of the underlying mechanisms of past drought variability.

Atmospheric carbon dioxide tracks climate and land carbon changes during the past millennium

T. K. Bauska (1)

(1) University of Cambridge, Department of earth sciences, Cambridge, United Kingdom

The land carbon reservoir is predicted to turn into a net source of carbon to the atmosphere if global warming continues unabated. Multi-decadal, global-scale observations are needed to test this prediction by adding uncertainties to projections of atmospheric CO2 and climate. Ice core records of the last millennium document atmospheric CO2 variations on multi-decadal to centennial timescales but attempts to constrain the underlying drivers of atmospheric CO2 using the stable isotopic composition of atmospheric carbon dioxide (813C–CO2) have been limited by the precision and temporal resolution of existing data. This spurred discussion on the magnitude of climate–carbon feedbacks and emissions from past anthropogenic land use change.

We developed a new high-resolution, high-precision ice core record of 813C–CO2 and use it to show that terrestrial organic carbon likely controlled multi-decadal scale atmospheric CO2 variability from 760–1850 C.E. If significant long-term carbon emissions came from pre-industrial anthropogenic land-use changes, they must have been offset by some natural 13C depleted land sink, plausibly peatlands. On multi-decadal timescales, carbon cycle changes appear to covary with reconstructed regional climate changes, consistent with climate as an important driver of land carbon storage on these time scales.

Our new observations present a challenging benchmark for models attempting to simulate the climate and carbon cycle of the past in order to understand the projections for the future. However, reducing the uncertainties in past temperature reconstructions and developing stronger constraints on pre-industrial anthropogenic emissions is likely needed to provide further insight into climate–carbon cycle interactions.
Climate and the water-energy-food nexus
C. Dalin (1)
(1) LSE, Grantham research institute, London, United Kingdom

Water, energy and food are essential for human well-being, and socio-economic development. Global projections indicate that demand for these resources will increase significantly in the next decades, under the pressure of population growth, economic development, urbanisation, diversifying diets, cultural and technological changes, and climate change (Hoff 2011). Annual and seasonal climate variability as well as climate change lead to reduced water availability and crop yields, which, combined with projected population growth, reinforces the need for planners to collaborate across sectors and account for climate variability and change. Recognition of spatial and sectoral interdependencies in the nexus should inform policies, investments and interventions for enhancing water, energy, and food security, and thus support sustainable development in climate-sensitive environments. This presentation will highlight the importance of recognising these linkages, and identify spatial and topical hotspots in current nexus research.

Revising the planetary boundary for freshwater use
D. Gerten (1)
(1) Potsdam Institute for Climate Impact Research, Potsdam, Germany

Nine intertwined ‘planetary boundaries’ demarcate the multidimensional ‘safe’ space for key earth system processes. For freshwater, this is the terrestrial freshwater limit of the environmental imprint of collective human activities. Earth may be moved out of its Holocene status which up to now enabled the development of a human society of several billion people. While the concept and quantitative basis of planetary boundaries has recently undergone a comprehensive update (Steffen et al., Science, 2015), some boundaries still require a more robust quantification, especially regarding regional patterns and differences in both the planetary scale and in terms of boundary interactions. Moreover, comprehensive assessments of development pathways for civil society under the constraint of planetary boundaries are still lacking.

This talk shows ways to improve the definition and assessment of the planetary boundary for human freshwater use, which is challenging as the regional pattern of water availabilities and limitations and the tight interactions with land cover and use are to be considered. The core approach is to account, spatially explicitly, for the environmental flow requirements of riverine ecosystems, which define local limitations to human water use and serve as a basis for a geographically explicit ‘bottom-up’ estimation of the planetary boundary. A pilot assessment – based on high-resolution simulations with a dynamic global vegetation and water balance model – indicates that the value of the planetary boundary may be lower than previously suggested earlier. Different estimation methods to assess environmental flows suggest a value between 1,100 and 4,500 km³ consumptive freshwater use per year (original estimate from Rockstrom et al., Nature 2009: 4,000 km³ per year). Thus, humanity’s current consumptive water use is already exceeded in many places, such as in parts of southern Europe, southern Asia, the Near and Middle East, and in the western US. Building on these results, the presentation elaborates on how the definition and quantification of the freshwater boundary can be further improved, for example by including “green” water, by specifying linkages with other planetary boundaries (such as the one for land-system change), and by water ethical considerations. Initial estimates of the potential of improved on-farm water management to increase crop production while staying within the planetary boundaries for freshwater use and land-system change are also presented.

Land use changes and their impacts on climate
J. Pongratz (1)
(1) Max–Planck Institute for Meteorology, Hamburg, Germany

About three quarters of the ice-free land surface have undergone some form of land use change: about one quarter has undergone a change in land cover, in particular deforestation for agricultural expansion; on another one half the vegetation cover has been kept but is managed, as happens e.g. in forestry. This land cover change and land management affects climate through multiple pathways. The political focus mostly lies on land use change as contributor to the human-induced rise in atmospheric CO2 and thus global warming. The local-scale climate, more relevant for adaptation, can show strong effects due to biogeophysical effects such as changes in water and heat fluxes.

Land use change (mostly restricted to land cover change) has therefore entered into most Earth system models (ESMs) used to project climate change. With the Coupled Model Intercomparison Project 5 (CMIP5) land use change has for the first time been considered in the climate simulations underlying the IPCC assessment report. However, the spread across model results for both carbon cycle and biogeophysical aspects has been found to be substantial. This initiated a range of studies that aim at understanding the reasons why estimates differ so much. These findings can be arranged along a chain of uncertainties from uncertain land use datasets, differences in their implementation in ESMs, to various definitions of land-use-induced carbon fluxes in models. This talk will discuss these sources of model spread and ways forward to reduce the uncertainties.

Understanding the sources of uncertainty is particularly important now: Recent observational studies suggest that land management can have effects on climate that are of similar strength in the time of rapid land cover change, yet occur on much larger area. The ESM community is therefore moving beyond land cover change towards land management for a more complete representation of the human impact on climate.

Terrestrial carbon cycle feedbacks in the climate system
L. Mercado (1)
(1) University of Exeter, Exeter, United Kingdom

Terrestrial ecosystems take up around a quarter of the human CO2 emissions from fossil fuel burning, land use and land cover changes each year (Le Quéré et al., 2015), mitigating climate change for the present day. Can we rely on this carbon sink in the future?

Terrestrial ecosystems store a vast quantity of carbon in biomass and soils and their storage capacity depends on environmental conditions. Elevated CO2 is known to act as a fertilizer, stimulating plant production, and a changing climate will lead to further warming. The local-scale climate, as e.g. temperature and precipitation) will alter the lifetime of carbon in plants and soils. For example, the seminal work by Cox et al., (2000) suggested that future warming will lead to a release of carbon from terrestrial ecosystems, through temperature-enhanced soil decomposition, and highlighted the vulnerability of tropical forests to climate change. This represents a positive terrestrial carbon cycle feedback, whereby an initial warming leads to a terrestrial release of CO2, which in turn leads to further warming.

Subsequently much research has focused on the role of terrestrial ecosystems and their feedbacks in the Earth system. Here we review the current state-of-the-art knowledge drawing from the latest synthesis in the IPCC AR5 WG1 report, and our research at the University of Exeter, Met Office Hadley Centre and Centre of Ecology and Hydrology, UK. In particular, we present the effect of aerosols, implications of plant acclimation to temperature,
Global impacts of climate change on terrestrial biodiversity and ecosystem service supply

W. Cramer (1)
(1) CNRS, Imbe, Aix-en-Provence, France

Impacts of recent climate change have been observed and attributed worldwide. Many of these affect land ecosystems, their function and the diversity of organisms in them. Scenarios of future warming, changes in rainfall patterns, rising sea levels, and species range shifts (Huntingford et al., 2009, Booth et al., 2012, Huntingford et al., 2013). I will highlight the key uncertainties in our understanding of climate–terrestrial carbon cycle feedbacks, and present recent work on emerging constraints on climate carbon cycle feedbacks (Cox et al., 2013, Wenzel et al. 2014).

K-L1.2-06

Climate Change and Ocean Systems: Introduction and Background

JJ. Gattuso (1)
(1) CNRS, Université Pierre et Marie Curie, Laboratoire d’Océanographie de Villefranche, Villefranche-sur-mer, France

The ocean moderates climate change at the cost of profound alterations of its physics, chemistry, ecology, and services. However, despite the ocean’s critical role in global ecosystem processes and services, integrated climate and ocean negotiations have only minimally touched on ocean impacts. Any new climate regime that fails to minimize ocean impacts will be incomplete and inadequate. This session, as well as session «2207: Ocean Change: Understanding and projecting the impacts of warming and acidification on natural and human systems» on Wednesday afternoon will provide an integrated and updated perspective on the changes, risks and projections for both natural and human systems. This will provide the construction of key messages for the COP21 negotiation process on the Ocean and associated issues.

K-L1.3-02

Challenges to ocean life and associated human interests: IPCC assessments and beyond

HO. Pörtner (1)
(1) Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany

Oceans cover more than 70% of the planet and their biota create half the oxygen humankind uses to breathe and burn fossil fuels. Oceans cover about 11% of the global population’s demand for animal protein. Climate change causes oceans to warm and stratify, and sea level to rise, as well as Arctic summer sea ice to shrink. Ocean warming accounts for more than 90% of the energy accumulated in the climate system. Warming causes oceans to lose oxygen overall and during an expansion of hypoxic water layers. Concomitantly, the accumulation of anthropogenic CO2 in oceans decreases water chemistry and causes acidification. These climate drivers alter ocean ecosystems and the services they provide. They frequently relocate and reduce marine biological resources on which human societies depend, affecting economic benefits, livelihoods, food availability and public health particularly for coastal communities. The recent IPCC assessment reports (AR5) as well as the Structured Expert Dialogue have comprehensively considered impacts, vulnerability, adaptation options and projected climate risks for the oceans and their services to humankind. Ocean warming has caused geographical shifts in the distribution of marine species, associated with changes in the species composition and function of ecosystems. Recent meta-analyses indicate that ambient temperature and hypoxia extremes in some regions are already close to permanent tolerance limits of marine animals and plants indicating a risk of expanding water bodies void of higher marine life. Climate warming and acidification will interactively and synergistically decrease the biogeochemical resilience of marine ecosystems to disturbances and constraints of its physics, chemistry, ecology, and services. However, despite the ocean’s critical role in global ecosystem processes and services, integrated climate and ocean negotiations have only minimally touched on ocean impacts. Any new climate regime that fails to minimize ocean impacts will be incomplete and inadequate. This session, as well as session «2207: Ocean Change: Understanding and projecting the impacts of warming and acidification on natural and human systems» on Wednesday afternoon will provide an integrated and updated perspective on the changes, risks and projections for both natural and human systems. This will provide the construction of key messages for the COP21 negotiation process on the Ocean and associated issues.

K-L1.3-01

Climate Change and Ocean Systems: Introduction and Background

JJ. Gattuso (1)
(1) CNRS, Université Pierre et Marie Curie, Laboratoire d’Océanographie de Villefranche, Villefranche-sur-mer, France

The ocean moderates climate change at the cost of profound alterations of its physics, chemistry, ecology, and services. However, despite the ocean’s critical role in global ecosystem processes and services, integrated climate and ocean negotiations have only minimally touched on ocean impacts. Any new climate regime that fails to minimize ocean impacts will be incomplete and inadequate. This session, as well as session «2207: Ocean Change: Understanding and projecting the impacts of warming and acidification on natural and human systems» on Wednesday afternoon will provide an integrated and updated perspective on the changes, risks and projections for both natural and human systems. This will provide the construction of key messages for the COP21 negotiation process on the Ocean and associated issues.

K-L1.3-02

Challenges to ocean life and associated human interests: IPCC assessments and beyond

HO. Pörtner (1)
(1) Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany

Oceans cover more than 70% of the planet and their biota create half the oxygen humankind uses to breathe and burn fossil fuels. Oceans cover about 11% of the global population’s demand for animal protein. Climate change causes oceans to warm and stratify, and sea level to rise, as well as Arctic summer sea ice to shrink. Ocean warming accounts for more than 90% of the energy accumulated in the climate system. Warming causes oceans to lose oxygen overall and during an expansion of hypoxic water layers. Concomitantly, the accumulation of anthropogenic CO2 in oceans decreases water chemistry and causes acidification. These climate drivers alter ocean ecosystems and the services they provide. They frequently relocate and reduce marine biological resources on which human societies depend, affecting economic benefits, livelihoods, food availability and public health particularly for coastal communities. The recent IPCC assessment reports (AR5) as well as the Structured Expert Dialogue have comprehensively considered impacts, vulnerability, adaptation options and projected climate risks for the oceans and their services to humankind. Ocean warming has caused geographical shifts in the distribution of marine species, associated with changes in the species composition and function of ecosystems. Recent meta-analyses indicate that ambient temperature and hypoxia extremes in some regions are already close to permanent tolerance limits of marine animals and plants indicating a risk of expanding water bodies void of higher marine life. Climate warming and acidification will interactively and synergistically decrease the biogeochemical resilience of marine ecosystems to disturbances and constraints of its physics, chemistry, ecology, and services. However, despite the ocean’s critical role in global ecosystem processes and services, integrated climate and ocean negotiations have only minimally touched on ocean impacts. Any new climate regime that fails to minimize ocean impacts will be incomplete and inadequate. This session, as well as session «2207: Ocean Change: Understanding and projecting the impacts of warming and acidification on natural and human systems» on Wednesday afternoon will provide an integrated and updated perspective on the changes, risks and projections for both natural and human systems. This will provide the construction of key messages for the COP21 negotiation process on the Ocean and associated issues.

K-L1.3-01

Climate Change and Ocean Systems: Introduction and Background

JJ. Gattuso (1)
(1) CNRS, Université Pierre et Marie Curie, Laboratoire d’Océanographie de Villefranche, Villefranche-sur-mer, France

The ocean moderates climate change at the cost of profound alterations of its physics, chemistry, ecology, and services. However, despite the ocean’s critical role in global ecosystem processes and services, integrated climate and ocean negotiations have only minimally touched on ocean impacts. Any new climate regime that fails to minimize ocean impacts will be incomplete and inadequate. This session, as well as session «2207: Ocean Change: Understanding and projecting the impacts of warming and acidification on natural and human systems» on Wednesday afternoon will provide an integrated and updated perspective on the changes, risks and projections for both natural and human systems. This will provide the construction of key messages for the COP21 negotiation process on the Ocean and associated issues.
need to be considered when setting the long-term global goals (LTGG) of climate change mitigation. As an example, the long-term risks of sea-level rise, Arctic sea ice loss and combined impacts of ocean warming and acidification on key groups of corals, bivalves and other calcifiers, that have high economic value in tourism, coastal protection and fisheries, strongly support setting the LTGG to but not above 1.5°C global warming above preindustrial values.

**K-L1.3-03**

**Oceans of Concern**

E. Poloczanska (1)
(1) CSIRO, Ocean and atmosphere flagship, Brisbane, Australia

Climate change and ocean acidification will reorganize food webs and alter ecosystem function, with attendant impacts on human communities and activities. The impacts of climate change have been detected across all oceans; changes to ocean have altered the timing of plankton blooms and migratory patterns and spawning in fish and invertebrates, over recent decades. Shifts in species distributions to higher latitudes are a commonly reported response of marine fishes and invertebrates to warming oceans. Differences in rates of change with climate change amongst species and populations imply that marine ecosystems may be substantially reorganized at regional scales. Indeed, at a global scale a strong warming signal is already evident in fish catches, with an increasing dominance of warm-water species found in catches coastal and shelf areas. Modelling approaches project a global redistribution of marine biodiversity this century with regional differences driven by species invasions and local extinctions. The emergence of novel assemblages of species with no past or contemporary analogues will consequently require new strategies for managing coastal areas and fisheries. Large changes in species composition are projected in both polar and tropical oceans with increases in species richness at high latitudes. High local extinctions are projected in equatorial oceans, particularly in the central Indo-Pacific, as species are eliminated with warming. The different futures emerge for tropical biodiversity by 2050s under high and low emission scenarios with widespread species losses and declines in species richness around the equator, particularly in the central Indo-Pacific, if global temperatures exceed the 2°C limit. Further, under the medium to high emission scenarios, ocean acidification poses substantial risks to marine ecosystems, particularly coral reefs and polar ecosystems. Climate change is a risk food resources, coastal livelihoods, and industries dependent on the ocean, adding to the threats of over-fishing and other non-climate stressors, and the likelihood of exceeding adaptation limits increases with greater rates and magnitude of climate change.

Nick Watts will present the key messages and recommendations from the Commission’s work.

**K-L1.4-03**

**Climate change, co-benefits and the global public health agenda**

N. Maria (1)
(1) World Health Organization, Geneva, Switzerland

Dr Neira will address the implications of the evidence presented for the wider public health agenda, and in making a positive contribution to the preparations for the UNFCCC CoP21 in Paris in December. This will include outlining how evidence is now being translated into a support programme to build health system resilience to climate change, focussing on the most vulnerable countries. It will also focus particularly on the opportunities for large, local health co-benefits of climate change mitigation policies, particularly in reducing the over seven million annual deaths that WHO estimates are attributable to air pollution.
**L1.5 – Climate variability, change and vulnerability in the Pacific, Indian and Southern Oceans**

**K-L1.5-01**

**ENSO and the Tropical Pacific in a Changing Climate**

M. McPhaden (1)  
\[1\) NOAA/PMEL, Seattle, United States of America

The El Niño/Southern Oscillation (ENSO) cycle represents the strongest year to year fluctuation of the climate system on the planet. El Niño, the warm phase of ENSO, and La Niña, the cold phase of ENSO, arise through coupled ocean-atmosphere interactions in the tropical Pacific mediated by positive feedbacks between surface wind and sea surface temperature variations. Warm and cold ENSO episodes lead to global shifts in patterns of weather variability that cause droughts, floods, heat waves and other extreme events around the world. ENSO-related natural disasters have significant consequences for society in terms of lives lost, property damage and economic viability. Understanding how ENSO may change in the future as a result of anthropogenic greenhouse gas forcing is therefore a compelling question that has challenged the scientific community. This presentation will review our current understanding of ENSO dynamics, predictability, and societal impacts. It will also assess current efforts to understand how ENSO may change in the future based on analyses of the instrumental record, CMIP models, and paleo data.

**K-L1.5-02**

**Indian Ocean interannual to decadal variability in the context of climate change**

J. Vialard (1); W. Han (2); M. Lengaigne (3); A. Nidheesh, (4)  
\[1\) IRD, LOCEAN, Paris, France; (2) University of Colorado, Boulder, United States of America; (3) UPMC, Paris, France; (4) National Institute of Oceanography, Goa, India

In the sixties, the Indian Ocean was the focus of the oceanographer’s international community due to its dynamic response to monsoons. In the eighties, this focus shifted entirely to the neighboring Pacific, birth of the El Niño Southern Oscillation (ENSO), most powerful intranannual climate mode on earth. It is only at the turn of the century that the Indian Ocean came back into fashion with the discovery of its own intrinsic interannual climate variability (the Indian Ocean Dipole) and the development of a basin-wide observing network. After reviewing interannual variability of the Indian Ocean, I will turn to the natural decadal climate variability, which has comparatively been much less described in this basin than in the Pacific and Atlantic Oceans. I will in particular question if this decadal variability purely arises from the neighbouring Pacific or if an intrinsic variability also exists in the Indian Ocean. The climate change signal will finally be discussed in the Indian Ocean. We will show, on the particular example of anoxic events along the west coast of India, how long-term trends and shorter-term variability can cause extreme events with important societal consequences.

**K-L1.5-03**

**21st century projections for the Pacific region**

S. Power (1); M. Collins (2); K. Hennessy (3); E. Guilyardi (4)  
\[1\) Bureau of Meteorology, Cawcr, Melbourne, Australia; (2) Exeter University, Exeter, United Kingdom; (3) SCIRO, Dickson, Australia; (4) LOCEAN/IPSL, UPMC case 100, Paris, France

Here we will examine the latest scientific information available on projections for climate in the Pacific, and what this means for developing island states in the region. Particular attention will be paid to changes in surface temperature, winds, rainfall, El Nino, tropical cyclones, and ocean acidification, for different scenarios of future greenhouse gas emissions. The continuing importance of decadal climate variability for the region will also be highlighted. This presentation will draw on summarizing the latest IPCC report and more recent research, including research conducted in the Pacific Australia Climate Change Science and Adaptation Planning Project.

**K-L1.5-04**

**Southern Ocean in a changing climate**

A. Thompson (1)  
\[1\) Caltech, Los Angeles, United States of America

Recent Southern Ocean studies have suggested a slowdown of ocean carbon sequestration, an acidification of the water-masses, an overall warming and freshening in the vicinity of Antarctica, and drastic changes in sea-ice and ice-shelf distributions. Observed changes are profound: the warming rate is faster than the global average, and occurs in the deepest layers of the ocean, therefore isolating the climate signal for decades to millennia; ice-shelves are melting, which accelerates the discharge of the ice sheet via the ice streams, and has a direct and major impact on the global sea level rise. These important changes are directly related to the large-scale circulation of the Southern Ocean and the associated biogeochemical cycle. This talk aims at summarizing our current understanding of how the large-scale circulation of the Southern Ocean works, how it impacts the carbon cycle, and how interactions with the Antarctic cryosphere influence it.

**O-L1.5-01**

**Future changes in the South Pacific convergence zone and its tropical cyclones using regional dynamical downscaling**

M. Lengaigne (1); M. Badon (2); C. Menkes (3); J. LeFèvre (4); N. Jourdain (5); S. Jullien (6); P. Marchesiello (7); S. Thibaut (8); L. Terray (9)  
\[1\) UPMC, Paris, France; (2) CERFACS, Climate Modelling and Global Change, Toulouse, France; (3) IRD, LOCEAN, Noumea, New Caledonia; (4) IRD, Legos, Noumea, New Caledonia; (5) CNRS, LGge, grenoble, France; (6) UPMC, Locean, Paris, France; (7) IRD, Legos, Toulouse, France; (8) CNRS, Legos, Toulouse, France; (9) CERFACS/CNRS, Sciences de l’Univers au CERFACS, URA1875, Toulouse, France

The South Pacific Convergence Zone (SPCZ) is the largest convective area of the Southern Hemisphere and has been recognized as a hot spot for climate variability (CLIVAR, 2012) as its functioning is poorly understood. Regionally, the SPCZ is the main source of rainfall in a vast majority of the Southern Pacific Island nations and the strong precipitation gradients related to the SPCZ make local hydrological conditions very sensitive to small displacement of this rain belt. The interannual variability of the SPCZ location is related to the El Niño/Southern Oscillation. El Niño events tend to occur accordingly with a north-eastward displacement of the SPCZ and La Niña events tend to occur with a southwestward displacement of the SPCZ. During strong El Niño events, the SPCZ undergoes an extreme swing by up to ten degrees of latitude toward the equator and collapses to a more zonally oriented structure. The SPCZ location now only slightly constrains the hydrological cycle but is also the breeding ground of tropical cyclones (TCs) in the South Pacific, as it combines all the large-scale atmospheric conditions that favor the genesis of TCs. Current climate models poorly reproduce the key characteristics of the SPCZ, leading to large uncertainties in the potential evolution of the South Pacific TC activity. Hence, assessing the SPCZ and its tropical cyclones in the future climate remains a challenge.

Here, we use a dynamical downscaling approach. Using results from an ensemble of 14 CMIP3 climate models under the SRES-A2 greenhouse gas scenario, we force a regional configuration of the WRF atmospheric model. The configuration uses a two-way nesting approach to increase the spatial resolution from 1° to 1/3° in the SPCZ region. We first perform a control simulation forced by the NCEP2 reanalysis over the past 30 years, and a future
simulation based on an anomaly method (e.g. Zhao et al. 2009), where we add the mean 21st century regional SST warming pattern and atmospheric change along lateral boundaries to the NCEP2 fields.

Results show an accurate representation of the SPCZ location, its north-south displacements in response to El Niño/Southern Oscillation, as well as a correct TC distribution in the region. The future simulation indicates an increase of the precipitation within the SPCZ and the equatorial region, and a decrease northeast of the SPCZ mean location, in good agreement with climate models. The mean SPCZ location under future conditions presents a southward shift in its eastern part, and generally an increased variability of its interannual geographical position. We also find more frequent strong El Niño events in the future, with zonally oriented SPCZ. We explore the respective role of increased greenhouse gases in the domain versus the role of lateral boundaries. Large–scale conditions from lateral boundaries induce a significant (~20%) decrease of cyclones frequencies in the region. However, greenhouse gases locally counter this decrease. Overall, we do not find any significant change of cyclone frequencies in the Southwest Pacific in a warmer climate, in contrast with most recent studies, which find a decrease of cyclogenesis (~6% to ~34%) according to references gathered in Knutson et al. 2010).

L2.1 - Drivers of Change and Visions of Development: Are Climate Policy and Development Compatible Goals?

K-L2.1-01

Energy Transition towards Two-Degree Target: The Case of China

K. Jiang (1)
(1) National Development and Reform, China

Abstract not communicated

K-L2.1-02

The Climate-Development ‘Conflict’: Asking the right questions

N. Rao (1)
(1) IASSA, Energy, Laxenburg, Austria

There is both confusion and concern regarding the impact of poverty eradication on climate change. Some equate poverty eradication with coal use, particularly in India and China; others assume consumption from people rising out of poverty would be highly material-intensive. What if all the world’s poor had refrigerators? What implications does economic development have for stabilizing climate change at 2 degrees C? Conjectures abound, but scientific research so far offers few real answers to these questions. This is in part because we haven’t been asking the right questions. What stands between poverty eradication and greenhouse gas emissions is the nature of developing countries’ development pathways, income distribution patterns of energy use, technological development, and different scenarios of global cooperation on climate change. There is much yet to be learned about the interaction of these drivers. New approaches to quantifying human development and energy use show that there have been many low-carbon development pathways in the past, and that meeting basic needs may be less carbon intensive than growth in affluence. Current trends in India reveal an exponential growth in low-carbon resources, even among the poor. While basic development aspirations cannot be lost, how the climate change is by no means outside the realm of influence by both national and international policy.

L2.2 - New pledges (INDCs) for 2025/2030: Are they reinforcing development and consistent with a 2 oC pathway?

K-L2.2-01

INDCs and development objectives

N. Dubash (1)
(1) Centre for Policy Research, India

Abstract not communicated

K-L2.2-02

What science tells us about the emission levels for a 2oC pathway

P. Ciais (1); T. Gasser (2); P. Friedlingstein (3); G.P. Peters (4); J. Rogelj (5)
(1) IPSL, Lsce, Gif-sur Yvette, France; (2) LSCE, Gif-sur-Yvette, France; (3) University of Exeter, Exeter, United Kingdom; (4) Center for International Climate and Environmental Research, Oslo, Norway; (5) IIASA, Laxenburg, Austria

Limiting global warming to below 2°C above pre–industrial levels will require sustained and important efforts to reduce anthropogenic emissions of greenhouse gases and to enhance and maintain sinks of carbon dioxide in the land-use sector. Fossil fuel CO2 emissions have continued to grow at an average rate of 2.5% per year over the past decade. Even at today’s annual emission levels, the cumulative CO2 emission quota in line with staying below 2°C would be exhausted in less than 30 years. We will examine how pledges of largest emitting countries to reduce emissions, or maintain sinks in the land–use sector are consistent with a trajectory enabling not to breach the international agreed 2°C temperature limit. In particular, we examine how forest carbon sinks in the US, Canada, Russia, China and the EU, as well as reduced deforestation in tropical countries, can help efforts to attenuate near-term climate change. A specific attention will also be given to the contribution of nations to historical radiative forcing and, climate change, including long-lived greenhouse gases and short-lived forcers such as CH4 and aerosols, of which the latter can have a climate cooling or warming effect.

K-L2.2-03

Assessment of intended nationally determined contributions to a 2015 international climate agreement

M. den Elzen (1); N. Höhne (2)
(1) PBL Netherlands Environmental Assessment Agency, Department of Climate, Air and Energy, Bilthoven, Netherlands; (2) New Climate Institute, Cologne, Germany

One of the most fundamental questions in the preparation of a new international climate agreement is whether countries’ proposals to reduce greenhouse gas emissions after 2020 are equally ambitious or not compared to their peers. Methodologies to rate countries’ climate action often rate different things and therefore come to different conclusions (Surminski and Williamson, 2014). From the variety of methods that have been applied in the past to rate the ambition of countries climate action proposals, we distinguish two main strands, which are described here as black and white for illustration, acknowledging that they overlap in practice. Both relate to the principle of common but differentiated responsibilities and respective capabilities:

- Moral obligation: From this viewpoint, countries have a moral obligation to reduce their emissions. This moral obligation can be measured in a simple way, e.g. for developed countries as the sustained emission reduction...
effort since 1990 (a commonly used base year) or more sophisticated using a variety of equity principles, so called "effort sharing" calculations (including the IPCC AR5 equity database (Clarke et al., 2014; Höhne et al., 2014)). This strand relates to the "differentiated" element of the agreed principle.

- Technical necessity: The starting point of this viewpoint is whether the proposal is in line with what is technically necessary from the standpoint of the moral obligation. This could be judged by whether the countries' proposal is in line with its contribution in globally cost-effective model pathways according to scenarios such as those included in the IPCC AR5 scenario database (Clarke et al., 2014) and model comparison studies, like LIMITS (Tavoni et al., 2015), leverages all mitigation potential, or covers all polices that the country's peers undertake. This strand relates more the "common" element of the agreed principle.

The two strands may lead to fundamentally different outcomes. A developing country for example may have limited moral obligation, but significantly more mitigation potential, as developing countries are characterized by higher energy and carbon intensities, have rapidly rising baseline emissions and a high share of new infrastructure (Clarke et al., 2014). For a developed country it may be the other way around, it may have a very high moral obligation, but may or may not have technical difficulty to reduce domestic emissions in the same order of magnitude without retiring old infrastructure before the end of its life ("carbon lock in" or "stranded assets").

The methods are applied illustratively to the recent post-2020 climate proposals by the USA, China and the EU. The results differ substantially per method, which confirms that a comprehensive ambition assessment is necessary to provide the full picture.

References:

K-L2.2-04

Integrating development and climate policy in South Africa

T. Caetano (1)
(1) University of Cape Town, Energy Research Centre, Cape Town, South Africa

South Africa's approach to its INDC will very likely be framed by development and climate. The formal process of consultation by government has yet to take place, but we know that the National Development Plan (NDP) is as important as South Africa's climate policy. Some research we have undertaken at the Energy Research Centre (ERC) illustrates the challenges of seeking a substantial reduction in poverty, inequality and emissions.

The key question facing the mitigation community in South Africa is the path within which the country can decarbonize the energy sector, which currently accounts for the majority of total emissions, without undermining development imperatives – the NDP places reduction of poverty and inequality at the top of a list of multiple priorities.

The current structure of the South African economy has resulted in sub-optimal environmental (high carbon intensity) and social (high Gini-coefficient and low HDI) outcomes. High levels of poverty and inequality are likely to be exacerbated substantially by climate change impacts in the future, while a reliance on energy- and capital-intensive, and low-labour-absorbing sectors means that even with a sophisticated tax and redistribution system, there are simply too few employed and skilled citizens in the economy to drive improvements in living standards and to indicate any significant responsiveness to climate change. Inclusive growth is a necessary condition for attaining better socio-economic outcomes in the future, but the type of growth that South Africa has experienced in the past few decades has not been sufficient.

A key question then is the extent to which a structural change in the economy can meet both mitigation and development objectives. Growth in sectors that are labour-intensive, absorb low- and un-skilled workers and are low carbon need to be incentivized if South Africa is going to move forward with climate compatible growth and development.

The domestic policy system is characterized, however, by lock-in and path dependency. While consultations on the INDC are ongoing, ERC research suggests that what is crucial is an understanding of how a just transition over the next decades from an inequitable and carbon intensive economy to a more equitable and low carbon economy can be achieved. South Africa's national climate policy, as indicated in 2009, is that its emissions will follow a 'peak, plateau and decline' trajectory to 2050. The NDP includes an environmental chapter that talks of an "equitable transition to a low-carbon economy", yet this remains to be fully integrated with chapters on economy, employment and infrastructure. ERC research has provided initial analysis on what would be required, either with more skilled work force or possibly a different structure of the economy, to move toward a successful integration of development and climate policy.

K-L2.2-05

The economic and competitiveness dimensions of the Draft Chilean INDC

A. Rudnick (1)
(1) MAPS Programme, Latin America, Santiago, Chile

Chile’s national contribution to mitigation is based on a commitment to reducing greenhouse gases for the post-2020 period. It is based on the sectorial analyses and the mitigation scenarios developed in 2013–2014 with MAPS Chile (Phase 2), the results of the National Greenhouse Gas Inventory, and additional information provided by the Ministries of Environment, Energy, Agriculture and the Treasury.

Chile aims to reduce its greenhouse gas emissions while decreasing poverty and inequality as well as continue advancing toward sustainable, competitive, inclusive and low-carbon development. To confront these challenges successfully, the country should direct all its efforts to decoupling economic growth from greenhouse gas emissions.

Draft Intended Nationally Determined Contribution on Mitigation

Chile analyzed a subset of three forms of contribution for the whole economy, namely: i) carbon intensity target, ii) a deviation below business as usual scenario specified ex ante, and iii) trajectories. From a review of existing literature and considering the national experience with the Copenhagen pledge, Chile has chosen to report its INDC based on the following three key elements:

a) a carbon intensity target, expressed in greenhouse gas emissions per unit of economic development (GDP) which includes all sectors where mitigation is possible, including forestry except for forestry; and b) a separate target for forestry. t

The draft INDC was submitted to a national consultation process, where two options of carbon intensity target were consulted.

Option A: Chile is committed to reducing its CO2eq emissions per GDP unit by 30–35% below their 2007 levels by 2025. Chile is also committed to reducing its CO2eq emissions per GDP unit by 20% below their 2007 levels by 2025.
emissions per GDP unit by 40–45% below their 2007 levels by 2030.

Option B: Chile is committed to reducing its CO2eq emissions per GDP unit by 25–30% below their 2007 levels by 2025. Chile is also committed to reducing its CO2eq emissions per GDP unit by 35–40% below their 2007 levels by 2030.

Figure 1: Upper value of Option A expressed in emissions (excluding LULUCF) per unit of GDP

Source: Draft INDC. Government of Chile. 2015.

In addition, for the forestry sector Chile has proposed restoring about 100,000 hectares of degraded land (forestation) within 20 years investing an estimated US$250 million, reaching an area of at least 100,000 hectares of managed native forest by 2035.

National perspective

Chile already has concrete and ambitious goals and policies, and has consistent energy policies to move towards a clean, safe, sustainable matrix (Law on renewable energy, energy efficiency targets, carbon tax). Emission mitigation is seen as an opportunity to low-carbon development with multiple benefits such as job creation, improved population health, competitiveness and others.

The mitigation scenarios considered for the draft INDC were modeled through a dynamic stochastic general equilibrium model (in Phase 2 of MAPS–Chile) for two macroeconomic variables: increase in the value of GDP and increased employment. The values presented in the table below correspond to percentage deviations from the baseline from 2013 to 2030. The three scenarios represent the mitigation range included in Option A and Option B of the draft INDC.

Table 1: Macro economic effects of mitigation options

<table>
<thead>
<tr>
<th>Scenario</th>
<th>GDP</th>
<th>Employment</th>
<th>CO2eq Emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>2030</td>
<td>2030</td>
<td>2030</td>
<td></td>
</tr>
<tr>
<td>80/20 (Lower value of Option B)</td>
<td>1,2%</td>
<td>0,0%</td>
<td>-18,8%</td>
</tr>
<tr>
<td>Medio (Upper value of Option B and lower value of Option A)</td>
<td>6,7%</td>
<td>5,5%</td>
<td>-23,4%</td>
</tr>
<tr>
<td>Alto (Upper value of Option A)</td>
<td>7,4%</td>
<td>6,3%</td>
<td>-26,2%</td>
</tr>
</tbody>
</table>

Source: MAPS Chile results (Phase 2).

According to the GDP growth rate, the population projections, and the mitigation measures and policy choices considered in the three mitigation scenarios, the macroeconomic modeling results indicate that high mitigation scenario is not only the most ambitious in terms of emission reduction, but also verifies the largest increases in GDP and employment levels to 2030.

L2.3 - Climatic Variability and the Social and Human Dimensions of Vulnerability

K-L2.3-01

Extremes of climate variability and impacts on society: The drought and water crisis of 2014-15 in Southeastern Brazil

J. Marengo (1)
(1) CEMADEN, San Paolo, Brazil

Deficient rainy season during the austral summers of 2014 and 2015 over much of Southeastern Brazil affected the São Paulo Metropolitan Area (SPMA)-South America’s largest metropolis, home to 20 million people and where 10% of Brazilians live and a third of GDP is produced. Together with high temperatures throughout 2014 and up to January 2015 and a subsequent increase in water demand, the persistent lack of rainfall determined a drought situation, impacting on the use of water for human consumption, hydropower, as well as water for agriculture, creating an acute “water crisis” situation. In the last 60 years, some extreme dry events have impacted Southeastern Brazil, including the 1953–54 episode and the 2000–2001 as the most intense. Here we intend to assess how extraordinary the recent extreme drought that started in summer of 2013, persisted throughout 2014 and continued up to January 2015 was, and to analyze some of the main factors contributing to it.

The hydropower reservoirs—which account for around 70% of the country’s entire hydroelectric power generation—and the rivers feeding the Cantareira reservoir system, which provides almost half of the city of São Paulo’s water, were almost dry by the end of 2014. The severe drought of the summer 2014–2015 was associated with a wide, intense and very persistent high-pressure area placed from surface to the upper troposphere. The anticyclonic system that dominates the atmospheric circulation over eastern South America extended from the sea level to the upper troposphere inhibiting the distinctive seasonal convective activity. This anticyclone lasted 45 days, extremely rare in terms of duration and never previously recorded for that region.

The region of Cantareira region experienced the most severe drought during the summer of 2014, and this year corresponds to the warmest year in the region since 1962. Other drought years, as in 1971 and 2001 were also among the six warmest years during that period. Therefore, the worse water crisis in São Paulo during the warmest year during the last 52 years is a relevant example of climate change risk due to rising temperatures due to anthropogenic influences.

However, origins of the current water crisis go beyond the rainfall deficiency, to include an array of interconnected factors: the city’s surging population growth in the 20th century, a chronically leaky system that spills vast amounts of water before it can reach homes and the destruction of surrounding forests and wetlands that have historically soaked up rain and released it slowly into reservoirs. Rainfall over the Cantareira system has been decreasing during the last decades and the levels in 2014 were the lowest since 1940. Longer-term planning by regional governments has fallen short, and many residents are already enduring sporadic water cutoffs, some going days without it. SABESP, the state utility company has reduced its extraction from the reservoir by a third, cut its pump pressure at night, and offered discounts to customers who reduce their consumption. Some parts of the city are relying on water trucks to maintain their supply.

Managing multifunctionnality for Climate Smart Landscapes

C. Mbów (1)
(1) Institut des Science de l’Environnement, Faculté des sciences et techniques, Dakar-Senegal, Senegal

This presentation addresses the importance of managing trade-offs for sustainability in the face of climate change and how in particular the integrated landscape approach could be the one way to achieve many climate change related objectives. The presentation suggests a analytics for harnessing the climate smart landscape approach to the emerging climate challenges using some examples of practices that are suited to different contexts. From the historical footprints of the co-evolution between policy and science in the aim of achieving integrated solutions to climate/environmental crisis, we suggest some avenues on how to use landscape management principles in the design and the implementation of multiple goals, and what are the key barriers.
K-L2.3-03
Exploring the human dimension of urban resilience: perspectives from the Pacific region
D. Mcevoy (1)
(1) RMIT University, Melbourne, Australia

Cities in the Pacific region, which in many instances are already vulnerable to a range of natural hazard and weather-related events, will be faced by a multitude of resilience challenges in the future as a consequence of the interactions between a changing climate and rapid urbanization processes. These challenges are further complicated in the Pacific by land tenure arrangements, with tensions between municipal and customary land ownership often commonplace. Drawing from ongoing research activity as part of UN-Habitat’s Cities and Climate Change Initiative, the presentation will explore the human dimension of climate vulnerability in the capital cities of Honiara (Solomon Islands) and Port Vila (Vanuatu). Both these case studies have been affected by recent weather-related disasters as evidenced by the Honiara floods in 2014 and the impact of Cyclone Pam on Port Vila in 2015. Discussion of the human dimension of urban resilience will not only address the current and future hazard component but also how changing levels of exposure, sensitivity and adaptive capacity will affect the resilience of the urban system (and its component parts). Lessons learnt from this analysis have the potential to positively influence the development of adaptation pathways and the enhancement of local resilience strengthening activity.

Acknowledgements:
This work is a contribution from the Brazilian National Institute of Science and Technology (INCT) for Climate Change funded by CNPq Grant Number 573797/2008-0 and FAPESP Grant Number 2008/57719-9, and from a proposal funded by Microsoft–FAPESP grant number 13/50169-1.

K-L2.4-01
Early warning of climate tipping points
T. Lenton (1)
(1) University of Exeter, Exeter, United Kingdom

A ‘tipping point’ occurs when a small change in forcing triggers a strongly non-linear response in the internal dynamics of a system and a relatively stable state transitions to a new one. Large-scale ‘tipping elements’ have been identified in the Earth’s climate system that may pass a tipping point under human-induced global change this century. At the smaller scale of ecosystems, some tipping points have already been observed, and more are anticipated in future. Our capacity to forecast such abrupt, non-linear changes has historically been poor. However, much excitement has recently been generated by the theory that some approaching tipping points carry generic early warning signals. I will critically examine the prospects for gaining early warning of approaching tipping points. Promising methods are based on detecting ‘critical slowing down’ in the rate a system recovers from small perturbations, and on accompanying changes in the statistical distribution of its behaviour. I will show examples of early warning signals in paleo-data approaching past abrupt climate changes, and in models being gradually forced past physical climate tipping points. I will also discuss the conditions under which the methods fail. Finally, I will show an example of pronounced slowing down in observational climate data, for North Pacific sea surface temperatures, and explore the implications for well-known marine ecosystem ‘regime shifts’.

K-L2.4-02
Are there tipping points in terrestrial ecosystems?
M. Hirota (1)
(1) Federal University of Santa Catarina, Santa Catarina, Brazil

Terrestrial ecosystems have been undergoing unprecedented climate and human–induced disturbances, which are likely to push these systems towards changes in their physiognomies, structure, and functioning. It has been hypothesized that these new configurations may be alternative regimes of systems comprising vegetation–climate–disturbance interactions. Thus, one way of explaining the dynamics of ecosystems in transition may be the theory of multi-stability and concepts such as resilience, hysteresis and tipping points. However, whether such multiple regimes indeed exist in climate–vegetation–disturbance systems and whether we can identify and quantify tipping points of such systems still remain largely unclear due to various reasons such as the role of heterogeneity and multi–scale processes in amplifying or dampening hysteresis and environmental change. This highlights the need to inter– multidisciplinary its teams, which investigate such questions and help addressing management practices and preserving ecosystem services for future adaptation policies.

K-L2.4-03
Approaching Tipping Points: context, anticipation and community-based monitoring
M. Nuttall (1)
(1) University of Alberta, Department of anthropology, Alberta, Canada

From the Arctic to the tropics, Prairie and steppeland environments to high mountain areas, deltaic regions and low–lying ecosystems, people are observing and experiencing significant environmental shifts. However, it does not necessarily follow that they think about climate change as the most pressing issue affecting their lives. In this presentation, I discuss some aspects of how to understand the consequences of climate change, as well as identifying tipping points and thresholds, in a broader context. Rapid social, cultural and economic change, as well as impacts of resource management and resource development, quota systems, trade barriers and conservation policies, among many things, have significant implications for human security and livelihoods. In many cases, climate change merely magnifies existing societal, political, economic, legal, institutional and other challenges that people experience in their everyday lives. In the far north of Greenland, for example, while the thinning sea ice and melting glaciers are perceived as troubling and worrying, local people see economic opportunities for their communities in the form of emerging halibut fisheries. Yet, although dramatic changes in climate require people to respond in particular ways, transformations in global markets that affect small–scale fisheries often have greater consequences. And while the disappearance of sea ice and glacial retreat may indicate approaching tipping points, irreversible social, cultural and economic change was precipitated in the 1980s by environmentalist opposition to seal hunting, while the prospect of oil development and mining mean different kinds of tipping points in the near future. As they reflect on a changing climate, local people do so from the position of living through considerable social and economic transformation that may have nothing to do with environmental change.

In this presentation, I consider the above and then focus on two case studies. First, I build on literature around putting tipping points and anticipatory knowledge, I consider anticipation, how people think about the world around them, how they orient themselves and live toward the future, and how they create and select that world that is also undergoing a constant process of becoming and being remade. I discuss how a focus on anticipation in local settings would give us a greater understanding of a diversity of approaches to precaution, pre-emption and preparedness. Given the
challenges (as well as opportunities) that climate change brings forward. In other words, anticipation is inherent in everyday life and implicit in social relations and cultural practices, and how aspects of those relations and practices can emerge from anticipation, is a way to understand successful local strategies of adaptation, the nature of resilience and how people prepare themselves for uncertain futures. Second, I discuss some anthropological methods and prospects for identifying and gaining early warning of tipping points through reflections on collaborative and participatory-based community research. By way of example, I draw on an interdisciplinary project in the High Arctic environment of North Greenland (the EU-funded ICE-ARC project) which is working with communities to help them prepare for and negotiate change in the future. Central to this project is community-based monitoring, a process that not only seeks to identify early warning signs of tipping points, but something that builds local research capacity and puts in place a local observing system. This will help improve climate predictions for understanding the impacts of climate change and enable communities to build capacity towards ensuring sustainable livelihoods.

K-L2.4-04

Can we avoid the next tipping in Antarctica?

R. Winkelmann (1)
(1) PIK Potsdam, -, Germany

Sea level rise is a given consequence of anthropogenic climate change. How much and how fast it is going to rise will depend critically on the future evolution of the Antarctic Ice Sheet which stores water equivalent to more than 50 meters of global sea level rise. Most of West Antarctica’s marine ice sheet lies on an inland-sloping bed and is thereby prone to an instability mechanism, the so-called marine ice sheet instability. Recent observations suggest that the grounding line has probably already transgressed into the unstable regime in part of the West Antarctic Ice Sheet due to warm water intrusion into the shelf cavities. Similar topographic configurations are found in large parts of the East Antarctic Ice Sheet which holds marine ice equivalent to 19 meters of global sea-level rise, more than five times as much as West Antarctica. For Wilkes basin in East Antarctica, it has been shown that removing a specific coastal ice volume, a so-called ice plug, can destabilize the entire basin, leading to self-sustained ice discharge and long-term sea level rise of several meters. Here, we will explore the regions which might be subject to the marine ice-sheet instability, the processes potentially triggering it, and the consequences and implications for future sea-level rise.

K-L2.4-05

Effects of climate change and other driver of global changes on biodiversity

C. Bellard (1)
(1) Université Paris Sud, Paris, France

Current threats have greatly accelerated the rate at which extinctions occur. Climate change is expected to become one of the most important threat in the future (Bellard et al. 2012). In general, multiple threats, such as habitat destruction, invasive species, overexploitation, and climate change lead to a synergistic increase in species extinction risk. The combined impacts of multiple threats are also diminishing the capacity of natural systems to cope with the effects of these changes. Yet, over the past decades most studies have assessed the combined impacts of multiple threats individually. This approach can be ineffective and ecologically misleading, because the cumulative effect of different threats is not considered. Most of the conservation measures that are based on such studies consider a subset of threats, which may be of little benefit if other threats remain unaddressed. In addition, the combined impacts of different threats might be larger than the cumulative effect of each threat individually. Because little is known about the possible existence of interacting effects, quantifying the magnitude of potential synergies should become a priority.

Here, we propose to use two case studies at a global scale: biodiversity hotspot (Bellard et al. 2014), and USA to illustrate the need to consider multiple interactions between climate change and other threats. For instance, we will examine the effect of climate change including sea level rise and land use changes on biodiversity hotspot. We will discuss consequences between threats, species vulnerability and protected areas through the biodiversity hotspot. We will also discuss the potential impact of future interaction of climate change, land use changes, and invasive species for 196 endemic species across USA (Bellard et al., submitted). To this aim, we took into account the spatial distribution of biodiversity vulnerable to these threats. In particular, we found high cumulative threat values (＞2 threats) in some parts of the USA, with lower values in the central and western parts. Cumulative impact analyses also suggested that the return on investments for conservation purposes may be low when high cumulative threat areas with low species diversity require protection from many threats (e.g., Minnesota, Wisconsin, Michigan, Iowa states). These analyses provide a useful means of identifying where conservation measures and mitigation measures might be most effective, and which threats should be implemented in the future. Ultimately, we will further discuss why some actions are better than others in mitigating the future effect of climate change.


Bellard, C., Leclerc, & Courchamp, F. Combined impacts of global changes on biodiversity across the USA submitted

K-L2.5-01

Future landscapes of food supply and demand and implications for emissions

JF. Soussana (1)
(1) Inra, Paris, France

Climate change and the rise in atmospheric CO2 will reorganize food systems and alter agricultural productivity, with impacts on food security, land use and greenhouse gas emissions. Food security is still an issue for about 795 million undernourished people, mostly located in the least developed countries of the planet. The agriculture sector is already affected by climate change, with significant global negative impacts on crop yields and maize yields being observed over the last decades. The global food systems would be severely threatened under high end global warming scenarios. The agriculture, forestry and land use sector contributes to 24% of global anthropogenic greenhouse gas (GHG) emissions, with livestock alone estimated to contribute about 14.5% of total human induced emissions when a supply chain approach is considered. Globally, GHG emissions from agriculture could be reduced by 20-30% if less efficient producers would adopt the best practices of their peers, but something that builds local research capacity and puts in place a local observing system. This will help improve climate predictions for understanding the impacts of climate change and enable communities to build capacity towards ensuring sustainable livelihoods.

K-L2.5-03

Food and water security under climate change

J. Bellard (1)
(1) Inra, Paris, France

Direct impacts on production range from extreme climatic events, droughts and floods, to thermal stress and reduced yields. A large proportion of low income farmers are highly exposed to climate change. Forward-looking scenarios of plausible agricultural sector developments were developed...
Past and future weather-induced risk in crop production

J. Elliott (1)
(1) University of Chicago, Chicago, United States of America

The global food system has seen increased volatility in recent years, with spiking food prices blamed for civil unrest on several continents. Rising prices for global commodity products like soy, meat, and palm are increasingly driving deforestation around the globe, and with agriculture increasingly interconnected to global food and energy markets, weather-related risk and supply-side shocks have become a key issue or concern for governments and businesses alike.

Using archives from the Agricultural Model Intercomparison and Improvement Project (AgMIP) and the Intersectoral Impact Model Intercomparison (ISIMIP), we look first at the impacts of 65 years of continental and global extreme events using observation-driven models and data. We identify the most severe historical events in caloric terms at national and global scales and evaluate the ability of models and model ensembles to identify weather-induced extreme years, correctly assess the magnitude of large-scale extreme events, reproduce historical country-level variability, and reproduce spatial patterns of losses under extreme drought.

We next consider global crop models driven with large ensembles of climate model output (both under historical forcing and with future scenarios) to characterize present day risk and the extent of non-stationary risk in global crop production. We find increasing, and in many cases accelerating, risk of extreme crop losses even in scenarios with little to no climate-induced long-term mean changes. In some cases, one-year global-scale production loss events that would have recently been called 1-in-100 year events occur every 30-35 years by mid-century, and every 10-20 years by end-of-century. We discuss some regional and global protective measures that might be introduced, including increased trade, stock-hoarding, crop breeding, and improved forecasts, monitoring, and modeling.

Future landscapes of crop water supply and demand

T. Oki (1)
(1) University of Tokyo, Tokyo, Japan

The real hydrological cycles on the Earth are not natural anymore. Humans are now driving changes in atmospheric processes through emission of greenhouse gases and land changes directly and indirectly. Global mean temperature is projected to rise approximately proportional to the cumulative total anthropogenic CO2 emissions from 1870 (AR5, IPCC WGI). Temperature rise itself will have direct impacts on the availability of water resources through changing flow regimes in snow-dominated or glacier-effluent river basins, and it will also be associated with sea level rise because thermal expansion is one of the major causes of observed and projected sea level rises. Further, climate change is projected to alter hydrological cycles: changing temporal and geographical patterns of hydrological components, such as precipitation, evapotranspiration, runoff, and ground water recharge, and particularly in their extremes. Consequently, the frequency of floods and/or droughts is projected to increase some parts of the world.

However, as articulated in the AR5 of IPCC WGI, “Risk of climate-related impacts results from the interaction of climate-related hazards (including hazardous events and trends) with the vulnerability and exposure of human and natural systems”, increasing frequency of natural hazards, such as torrential rainfall or long-lasting heat wave, alone will not cause damages on human and natural systems, and both climate and social changes are relevant for planning sustainable development in the future.

AR5 (WGI) also says “Significant co-benefits, synergies, and tradeoffs exist between mitigation and adaptation and among different adaptation responses; interactions occur both within and across regions”. Mitigation and/or adaptation actions should not be planned in an isolated manner, but should be integrated into wider frameworks, such as integrated water resources management and sustainable development. Risk management and/or adaptation should be integrated into a risk management framework assessing and managing possible global risks, and ultimately pursuing increasing human well-beings.

These issues will be discussed with reviews of the latest estimates of water demand and supply in the future.

Planetary opportunities in crop water management: Potential to outweigh cropland expansion

J. Jägermeyr (1)
(1) Potsdam Institute for Climate Impact Research (PIK), Potsdam, Germany

A major humanitarian challenge for the 21st century is to feed the growing population in face of climate change and sustainability boundaries. However, as the planetary boundaries for freshwater and land use are being approached rapidly, there is little potential for additional cropland or irrigation. In addition, competition between food production, bioenergy plantations, and biodiversity conservation increases pressure, while considerable yield gaps remain in many world regions, and water use conservation methods proved instrumental to boost yields in a sustainable way. In the here presented modeling study we investigate, at global scale, to what degree smart on-farm crop water management might contribute to a sustainable global yield increase. We do this under current and projected future climate conditions and under the constraint of environmental flow requirements to represent the planetary boundary for human freshwater use. We further consider competition between food production, bioenergy plantations, and biodiversity conservation increases pressure.

Global yield simulations based on hypothetical scenarios of these management opportunities are performed with the process-based agro-biosphere model EPIC driven by reanalysis data and GCM simulations. We consider a range of 20 climate change projections to cover respective uncertainties, and we analyze the effects of increasing crop yields on the crops and their water demand. Crops are represented in a process-based and dynamic way by 12 crop functional types, each for rainfed and irrigated areas, per 0.5° × 0.5° grid cell. Irrigation is represented through a newly implemented dynamic irrigation module that accounts for beneficial and non-beneficial irrigation water consumption. Our results show that irrigation shifts to more efficient systems can save substantial amounts of water (54–76% of non-beneficial water consumption) at the basin level, and if used to transform rainfed into irrigated systems, can increase crop yields significantly in many major river basins (0.5–1.8% global increase). Global-scale irrigation transitions are however very expensive. Moreover, affordable low-tech solutions for small-scale farmers on water-limited croplands can increase yields to a similar extent. A simulated global −15% yield increase from a low-intensity water management scenario could outweigh, i.e., possibly avoid, an estimated 120 Mha of cropland expansion under current climatic conditions. A medium-intensity water management scenario holds the potential to increase global yields by more than 35% without expansion or withdrawing additional irrigation water. Climate change will have adverse effects on crop yields in many regions, but as we show such adaptation opportunities have the potential to mitigate or compensate these impacts in many countries. Overall, proper water management (sustainably maximizing on-farm water use efficiency) can substantially increase global crop yields and at the same time relax rates of land cover conversion.
K-L2.5-05

Agricultural Adaptation to Climate Change in Rich and Poor Countries

D. Lobell (1)
(1) Stanford University, Department of environmental earth system science, Stanford, United States of America

This talk will review the evidence on the effectiveness of adaptation in reducing climate change impacts in different countries. Much of the model-based evidence is relatively weak, not only in that it relies on models, but that it depends on strong assumptions about what farmers would do in the absence of climate change. A few observational studies have been published in recent years, which will also be reviewed. Overall, the challenge of adapting to climate change is formidable, and rapid learning will be essential for achieving as much reduction in impacts as possible.

K-L2.5-06

Adaptation to Extreme Weather Events by Farmers in China

J. Huang (1)
(1) Chinese academy of sciences , Center for chinese agricultural policy, Beijing, China

Growing evidence indicates that climate change has aggravated the intensity and frequency of extreme weather events in the past and will future aggravated in the future. Overcoming the challenge of increasing extreme weather events, particularly drought and flood, has captured much attention in many developing countries. In China, the annual average crop area suffering from serious drought and flood has also increased in recent decades. Key issues to be discussed in this presentation include: how farmers have responded or adapted to the extreme weather events? What are major measures that have been taken by farmers when they face serious drought and flood? How effectiveness of these measures in mitigating the risk resulted from the extreme weather events? How policy can facilitate farmers to better adapt to the rising intensity and frequency of extreme weather events in the future? Based on primary data from a large-scale field survey in China, the results show that when faced with severe drought or flood, farmers do take various measures to mitigate the climate risk. Most measures taken by farmers are related to investment in and management of water used in agricultural production. This new architecture, jurisdictional policy implications.

K-L3.1-01

The economic and policy structure of energy transitions

M. Grubb (1)
(1) University College London, Institute of Sustainable Resources, London, United Kingdom

This presentation will summarise key structural lessons from quarter of a century’s debate and experience in seeking to foster low carbon energy transitions, offering a new framework to explain how climate and energy challenges can be tackled more effectively whilst containing energy bills. It will explain three domains of socioeconomic processes each of which involves different actors and decisionmaking characteristics. These three domains operate at different scales of time and social entities and rest on different theoretical foundations. The unique characteristic of energy and climate change is that the issues raised span all three domains in approximately equal measure. The policy implication is the need for three distinct pillars of action, each being approximately equally important.

Drawing on the book Planetary Economics, co-authored with Professors Hourcade and Neuhoff, the presentation will explain from these foundations how the different pillars are complementary and why only packages spanning all three are credible, economically efficient and environmentally effective – and hence, politically stable.

K-L3.1-02

Carbon Markets: Past, Present and Future

B. Pizer (1)
(1) Sanford School of Public Policy, Duke University, Department of economics, Duke, United States of America

Carbon markets are substantial and expanding. There are many lessons from experience over the past 10 years: fewer free allowances, careful moderation of low and high prices, and a recognition that trading systems require adjustments that have consequences for market participants and market confidence. Moreover, the emerging international architecture features separate emissions trading systems serving distinct jurisdictions. The long-term consequences are particularly important in the terms of the legacy for future policies. If current regulations turn out to be inadequate to address future mitigation goals, debate could begin again over federal legislative options, namely, a tightening of the existing program, an explicit national trading program, emissions taxes, or other alternatives to reduce emissions such as renewable or clean electricity goal. In this event, it will be important to understand how responses to the current proposed regulation may affect the ability of the electricity industry to respond cost effectively to any new policies in the future as well as the distribution of future costs across stakeholders.

These programs are complemented by a variety of other types of policies alongside the carbon markets. In sharp contrast to the integrated global trading architecture envisioned 15 years ago by the designers of the Kyoto Protocol and raises a suite of new questions. In this new architecture, jurisdictions, with emissions trading have to decide how, whether, and when to link with one another, and policy makers overseeing carbon markets must confront how to measure the comparability of efforts among markets and the comparability of markets to a variety of other policy approaches.

An important recent development is the 2014 U.S. Environmental Protection Agency (EPA) proposed rules to regulate fossil fuel power plants under existing U.S. law. Final rules are expected this summer. The rules’ key features include state-by-state pollution limits and considerable flexibility for the states to achieve them. This flexibility includes the states’ choice to implement the targets through traditional regulation or the use of carbon markets. If implemented through carbon markets, states face additional questions about carbon market design. Different strategies for emissions reductions and regulation design will have important near-term consequences, in terms of the cost of electricity generation and market prices, and important long-term consequences, in terms of retirements and new investments. These consequences can vary significantly from region to region and from stakeholder to stakeholder.
K-L3.1-03

Carbon Pricing Future in China

J. Kejun (1)
(1) Energy Research Institute, National development and reform commission, Beijing, China

A global 2 Degree temperature increase was identified as a political target for climate change. The newly published IPCC AR5 presents a lot of research on scenarios, policies for 2 degree. A carbon pricing is one of the policy options for CO2 emission mitigation. In China, CO2 emissions trading was adopted as a policy for China’s low carbon development. The emission trading was launched in 2017 in 7 pilot cities and provinces. An implementation of carbon tax in China was widely discussed, and now is under decision making process in government. This presentation summarizes the analysis of a carbon tax based on the model ETS in China. It is concluded that the choice between carbon tax or emission trading in China. In the modeling analysis, in order to support the global 2 degree target, CO2 emissions in China have to reach peak before 2025 and then start deep cut on CO2 emissions. In IPAC modeling analysis, feasibility analysis for this emission scenario was developed. By using this detailed analysis modeling tool, it is feasible for China to peak CO2 emissions before 2025, and start deep cut after that, reaching more than 70% cut by 2050 compared with that in 2020. In the analysis, various policies were considered, including energy efficiency improvement, fuels switching in end use sectors, low carbon power generation, land use mitigation, carbon pricing etc. Based on China’s policy making regime, these policies could be implemented in different government agencies according to their functions. There has been a significant progress on energy efficiency improvement since 2005 when China started the energy conservation program as a national fundamental strategy. And in recent years, renewable energy development in China is also playing a large role in the world, accounting for nearly one third of the global production capacity for renewable energy added per year.

However, we do need to consider an economic method for GHG mitigation in China. We have started analysis on carbon tax and emission trading from 2005, by now ETS is undergoing, and a carbon tax was proposed to government. In the modeling analysis, it is found that carbon pricing has significant effects on CO2 emissions mitigation to reach the global 2 degree target, and could be implemented in China. By reviewing the progress of ETS in China, we have discussed the advantages and disadvantages of both carbon tax and ETS, and suggested the future pattern for carbon pricing in China. Carbon tax is strongly recommended as a national policy for GHG mitigation. A system to combine carbon tax and ETS in China is also proposed.

K-L3.1-04

India’s Energy and Climate Debate: Uncertainties in Future Emissions and the Scope for Co-benefits

N. Dubash (1)
(1) Centre for Policy Research, New Delhi, India

India occupies a dual position in global climate debates. As a large and rapidly growing economy, India’s future energy and emissions trajectory holds considerable implications for global climate change. On the other hand, India starts from a very low base of energy use and emissions on a per capita basis, illustrating the considerable future energy needs required if India is to meet the development needs of Indian citizens.

This duality frames Indian climate and energy policy. Given the low levels of current energy usage, poor quality of infrastructure, and the need to provide jobs for large numbers of people entering the workforce, the only acceptable starting point from a domestic point of view is India’s low energy needs and no energy ambitions. However, Indian policy formulation is able to consider climate impacts through explicit consideration of ‘co-benefits’ of alternative development policies. Hence, understanding and co-ordinating co-benefits is an important theme in Indian energy and climate policy.

This study reviews recent national energy and climate modelling studies to assess the projected range of future emissions, energy demand patterns and energy supply future. What emerges is a wide variation in projected business as usual futures. Policy scenarios included are a carbon tax, and bottom up demand and supply mix scenarios, leading to a relatively modest deviation from reference cases until 2030.

Key results include: a projected doubling or tripling of carbon dioxide emissions, and an increase in coal use by 2.5-3 times, despite considerable increase in renewable energy use. However, these projections assume continued high GDP growth rates until 2030, which partially drive these results.

Despite the importance of co-benefits, the studies do not systematically assess the co-benefits arising from various climate policies. However, a review of global integrated assessment models applied to South Asia do suggest that air pollution and energy security co-benefits in particular can be considerable.

Looking to the future, the co-benefits framing of India’s climate policy is likely to result in sector by sector policy formulation, driven primarily by sustainable development and energy security concerns, with some attention to climate benefits. The co-benefits analysis suggests that the climate gains in terms of ‘bending the curve’ could be substantial. In order to assess the magnitude of potential reductions in CO2 emissions arising from sectoral co-benefits, a comparison to sectoral scenario construction in future model runs.

K-L3.1-05

Mitigation of Energy-related GHG Emissions in Brazil

E. La Rovere (1)
(1) University of Rio de Janeiro, Rio de Janeiro, Brazil

Brazil is one of the largest developing economies in the world. Its long-run developmental pathway needs to face huge challenges, such as: poverty eradication, reduction of inequalities, food security, access to energy and water, public security, technological innovation and competitiveness. Climate change will have to be added to this list, due both to the country high vulnerability to climate change and to its important contribution to global GHG emissions. In this context, this presentation summarizes an analysis of the social and economic implications of different GHG emission mitigation scenarios for Brazil.

Brazilian voluntary commitment to reduce emissions until 2020 shall be reached thanks to the sharp cut on Amazon deforestation achieved since 2004. As the economy grows, emissions related to the combustion of fossil fuels for energy production and consumption have been increasing significantly and are expected to become the dominant source of GHG emissions over the next decade. Mitigation policies and measures, beyond those included in governmental plans, have been identified and grouped in scenarios up to 2030, according to expert judgement on assumptions about its economic and political feasibility resulting in different penetration rates of technological and management innovations.

Comparative analysis of the scenario results has allowed for highlighting economic (GDP, inflation, trade balance, industrial competitiveness) and social (employment, income distribution, low income household consumption patterns) implications of lower carbon alternatives in Brazil. These results provide new insights as an input to the national debate on the strategy to curb down country’s GHG emissions up to 2030.

In the past, different policy tools have been used in Brazil to foster the development of renewable energy in Brazil, including: a mandatory blending of ethanol to gasoline; soft loans to increase ethanol production; fiscal exemptions for planted forests of fast growing species such as eucalyptus and pinus, used for charcoal manufacturing; tendering of hydropower plants to be built through public/private partnerships; feed-in tariffs for power generation from wind farms, solar PV and biomass; among others. These instruments have enabled Brazil to reach a level of 45% of renewable energy in total energy supply in 2010, against a world average of 1.3%.

Now, different command/control and economic instruments may be used to promote a transition to a even lower carbon energy system: the creation of domestic...
L3.2 - Transformational Energy Technologies

K-L3.2-01

Game Changing Energy Technologies
S. Benson (1)
(1) Stanford University, Stanford, United States of America

Successful transformation of our energy system will require game-changing technological innovations. Some of these innovations are here today – for example photovoltaics and wind turbines. Some are likely to be coming soon, but require additional time and effort to decrease costs and scale them up to the enormous size of our energy system. Looking to the future, additional game changing technologies are needed and on the horizon: carbon capture and storage, renewal fuels made without plants, radiative cooling, just to name a few. Now is an incredibly exciting time to be involved in this important research endeavor. Indeed it is the challenge and opportunity of the century. In this presentation I will highlight the tremendous progress that has been made in renewable energy and present emerging innovations needed for a more sustainable energy future.

K-L3.2-02

Prospects for Carbon Capture and Storage
G. Hill (1)
(1) BP Alternative Energy, Global carbon sequestration technology group, London, United Kingdom

Carbon Capture and Storage (CCS) is likely to be a key technology in a world that has a plentiful resource of fossil fuels and cares about limiting CO2 concentrations in the atmosphere. With almost 20 years of development experience, CCS has still to break through the demonstration phase. However internationally a number of large scale projects are about to come on line which might change this perception. This talk will examine what our experience has taught us to date and what challenges remain for CCS.

L3.3 - Managing Transitions in Cities: Towards resilient, low-carbon cities

K-L3.3-01

Transition and transformation towards low carbon, resilient cities
X. Bai (1)
(1) Australian National University, Canberra, Australia

The facts that link cities and climate change are simple – cities contribute majority of CO2 emissions, and due to the high and growing concentration of population in cities and the geographic locations of world major cities, cities are also increasingly exposed of, and would suffer from, the impacts of climate change. It is increasingly recognized that transition and transformation towards low carbon and resilient cities are critical, and what we do in our cities, and how we do it, may largely determine our collective futures under climate change.

The importance of looking at cities in climate change is paramount, and the need for the role of cities to be better recognized and for cities to be better integrated in international climate change negotiations is essential. However, the real challenge lies in how can we initiate, manage, and achieve transitions and transformations that enable cities to become low carbon and more resilient. Drawing on recent studies and several examples, this paper explores such challenges and potential leverage points, from the following four aspects:

a) The complex and multifaceted linkages between cities and climate change: The linkages between cities and climate change are complex and multifaceted. Cities are the largest contributor of CO2, but they might also be more efficient in terms of delivering the same level of services. Recent research shows that cities impact on climate change have multiple pathways that go beyond contribution to CO2 emission. Such complexities are not fully recognized, nor they are reflected to inform policy and practice.

b) Contextualizing low carbon concept in rapidly urbanizing regions: The concept of low carbon and...
resilient cities often becomes a relative term and context specific. In regions undergoing rapid urbanization and economic growth, the goal of achieving low carbon and resilient cities can have drastically different meaning, which is often contradicted by other objectives that are more prevalent and given higher priority. For example, how to reconcile the tremendous need to provide urban housing and other infrastructure vs the task of reducing total carbon emission? Competing priorities exist within the same city or region. The question is: Are cities willing to choose between these radically different options? The ARC3 report, scheduled to be published in December 2015, is the first-ever global, interdisciplinary, cross-regional, and multi-sector report on climate change and cities. It is the first installment in this ongoing series, the Second UCCRN Assessment Report.

The UCCRN is now working towards launching the next installment in this ongoing series, the Second UCCRN Assessment Report. The ARC3 report is scheduled to be launched at COP21 in Paris in December 2015. The UCCRN is also launching its Case Study Docking Station later this year, providing examples of urban mitigation and adaptation initiatives from 100 cities across the globe.

New York City, one of the cities included in UCCRN’s Case Study Docking Station, is a leading example for urban climate change adaptation and resilience. The New York City Panel on Climate Change (NPCC) is an independent body that advises the City on climate risks and resiliency. Under the mayor’s leadership, the NPCC works closely with New York City’s comprehensive climate policies, positioning residents and planners to confront expected future changes in the most effective way possible. The NPCC was established in 2008 by then Mayor Michael Bloomberg as an ongoing collaboration between scientists and key stakeholders in the City of New York to integrate resilience against the future impacts of climate change into long term sustainable planning.

The NPCC released its first report in 2010 outlining the key impacts of climate change and setting forth a strategy to address climate change and to define emerging opportunities and implications for key urban sectors — water and sanitation, transportation, public health — and cross-cutting issues through land use and governance. The ARC3 report, containing 46 city adaptation and mitigation case studies, reproduces these findings and contributes to the effort.

The objectives of the UCCRN are to bring together experts working on global-scale, climate change and cities assessments in order to simultaneously present state-of-the-art knowledge on how cities are responding to climate change and to define emerging opportunities and challenges to the effective placement of this knowledge in the hands of local stakeholders and decision-makers.

The First UCCRN Assessment Report on Climate Change and Cities (ARC3) was published in 2011 by Cambridge University Press, and articulates urban climate risk frameworks, climate science for cities, and derives policy implications for key urban sectors such as water and sanitation, energy, transportation, public health — and cross-cutting issues through land use and governance. The ARC3 report, containing 46 city adaptation and mitigation case studies, reproduces these findings and contributes to the effort. The NPCC released its first report in 2010, outlining the key impacts of climate change and setting forth a strategy to address climate change and to define emerging opportunities and implications for key urban sectors — water and sanitation, transportation, public health — and cross-cutting issues through land use and governance. The ARC3 report, containing 46 city adaptation and mitigation case studies, reproduces these findings and contributes to the effort.

The objective of the UCCRN is to bring together experts working on global-scale, climate change and cities assessments in order to simultaneously present state-of-the-art knowledge on how cities are responding to climate change and to define emerging opportunities and challenges to the effective placement of this knowledge in the hands of local stakeholders and decision-makers.

The First UCCRN Assessment Report on Climate Change and Cities (ARC3) was published in 2011 by Cambridge University Press, and articulates urban climate risk frameworks, climate science for cities, and derives policy implications for key urban sectors — water and sanitation, energy, transportation, public health — and cross-cutting issues through land use and governance. The ARC3 report, containing 46 city adaptation and mitigation case studies, reproduces these findings and contributes to the effort. The NPCC released its first report in 2010, outlining the key impacts of climate change and setting forth a strategy to address climate change and to define emerging opportunities and implications for key urban sectors — water and sanitation, transportation, public health — and cross-cutting issues through land use and governance. The ARC3 report, containing 46 city adaptation and mitigation case studies, reproduces these findings and contributes to the effort.

The First UCCRN Assessment Report on Climate Change and Cities (ARC3) was published in 2011 by Cambridge University Press, and articulates urban climate risk frameworks, climate science for cities, and derives policy implications for key urban sectors — water and sanitation, energy, transportation, public health — and cross-cutting issues through land use and governance. The ARC3 report, containing 46 city adaptation and mitigation case studies, reproduces these findings and contributes to the effort. The NPCC released its first report in 2010, outlining the key impacts of climate change and setting forth a strategy to address climate change and to define emerging opportunities and implications for key urban sectors — water and sanitation, transportation, public health — and cross-cutting issues through land use and governance. The ARC3 report, containing 46 city adaptation and mitigation case studies, reproduces these findings and contributes to the effort.

The First UCCRN Assessment Report on Climate Change and Cities (ARC3) was published in 2011 by Cambridge University Press, and articulates urban climate risk frameworks, climate science for cities, and derives policy implications for key urban sectors — water and sanitation, energy, transportation, public health — and cross-cutting issues through land use and governance. The ARC3 report, containing 46 city adaptation and mitigation case studies, reproduces these findings and contributes to the effort. The NPCC released its first report in 2010, outlining the key impacts of climate change and setting forth a strategy to address climate change and to define emerging opportunities and implications for key urban sectors — water and sanitation, transportation, public health — and cross-cutting issues through land use and governance. The ARC3 report, containing 46 city adaptation and mitigation case studies, reproduces these findings and contributes to the effort.
urban transition processes successfully and how to set a solid fundament to achieve an appropriate implementation culture.

Cities often are the crucial driver and forerunner for significant changes on the national level (or even the international level). They are often focal point for political and cultural changes and provide the right framework for development and testing of (niche) innovations, innovations that have the potential for the necessary changes of socio-economic regimes (including institutional settings and consumer behavior respectively routines). With this regard cities can also be seen as perfect real laboratories. In cities socio-technical texture of modern societies can be found (comprising energy and transport system, provision of food and education etc.), but in comparison to states with a lower grade of complexity. Learning formats can be better placed under those conditions.

Against that background the presentation will provide major requirements for shaping carbon infrastructures and will give illustrative examples for successful practical steps.

Reduction of GHG emissions caused by cities plays a decisive role in the battle against climate change. Due to rapid urbanization in many parts of the world, particularly in the developing world, appropriate solutions have to be found for growing cities and even new agglomeration areas. In cities with mature infrastructures, their exemplary roles are especially important in demonstrating the cornerstones of a low-carbon transition, such as in their building and procurement systems. In addition deep retrofits, general procurement and mobility system transformation.

Systematic and coordinated strategic urban planning with effective stakeholder participation is of high importance for developing low-carbon urban infrastructures. Specification of mitigation priorities has to start at the very beginning with carefully identifying and addressing the needs and the challenges in each of the key sectors (including basic needs of inhabitants). The planning shall be based on robust scientific analysis, shall start with a solid analysis of the given urban infrastructures, the GHG emission sources (GHG Life Cycle), the inventory and their endogenous and exogenous driver. In addition the whole bunch of mitigation options (from smart energy efficiency services to decentralized renewable energy supply structures) has to be considered and properly assessed.

As consequence of high fixed costs of urban infrastructure measures and the long life span of those investments, within the planning process lock-in risks and path dependencies have to be considered carefully. In the long term with the growing implementation of energy efficiency measures to minimize embodied energy becomes more and more important. A better understanding of the value chain and of about how to change the existing relationships is therefore key.

For shaping suitable low-carbon infrastructures no blueprint is available and specific conditions of every city are crucial. However, exchange of experience can play an important role in finding the right solutions. With this regard international city networks and bi- or multilateral partnerships (e.g. in the context of existing twinning towns) can help to exchange experience of how to steer urban transition processes successfully and how to set a solid fundament to achieve an appropriate implementation culture.

Cities often are the crucial driver and forerunner for significant changes on the national level (or even the international level). They are often focal point for political and cultural changes and provide the right framework for development and testing of (niche) innovations, innovations that have the potential for the necessary changes of socio-economic regimes (including institutional settings and consumer behavior respectively routines). With this regard cities can also be seen as perfect real laboratories. In cities socio-technical texture of modern societies can be found (comprising energy and transport system, provision of food and education etc.), but in comparison to states with a lower grade of complexity. Learning formats can be better placed under those conditions.

Against that background the presentation will provide major requirements for shaping carbon infrastructures and will give illustrative examples for successful practical steps.

O-L3.3-03
Experiences from the ground: Case study from a City
D. Ürge-Vorsatz (1)
(1) Central European University, Center for climate change and sustainable energy policy (3csep), Budapest, Hungary
Abstract not communicated

K-L3.4-01
Strategic approaches for enhancing climate change adaptation of species and ecosystems
W. Foden (1)
(1) Global Change and Sustainability Research Institute, University of the Witwatersrand, Gauteng, South Africa

Even under best case mitigation scenarios, most species and ecosystems must undergo adaptation if they are to avoid extinction and maintain their functions under climate change. Published observations of such adaptation now number in the thousands and include shifts in species’ distributions and the timings of seasonal activities such as animal migrations and plant phenology. A large literature is also emerging, however, on the negative impacts of climate change on less adaptive species and ecosystems. The broad spectrum of impacts includes physiological stress and mortality, population and distribution declines, food web disruptions, and increased competition with dispersive ‘climate change immigrants’. Climate change challenges conservation strategies to make a strong shift from traditional preservationist approaches towards promoting adaptive changes while minimising negative impacts. Here I discuss emerging approaches for enhanced climate change adaptation of species and ecosystems and outline some of the key gaps and challenges in this field.

Projecting climate change impacts on species and ecosystems is an important early step in effective adaptation planning. This has driven rapid development of a suite of approaches and methods for assessing the vulnerability of species and ecosystems to climate change, generally by co-opting methods used for other purposes. Each differs in its strengths, weaknesses, resource requirements and suitability to different contexts, and no single one has emerged as the blueprint to do so in the near future. This introduces a considerable challenge for conservation practitioners, who must select between and learn to apply sometimes complex methods for their focal areas or ecosystems. Although filled in part by the forthcoming IUCN SSC guidelines for assessing species’ vulnerability to climate change, the gap between academic developments and their accessibility to practitioners remains a concerning challenge. Equally, assessing how human responses to climate change will impact on natural systems (e.g., changes in agriculture
ABSTRACT BOOK

K-L3.4-02

Operational interventions to assist the adaptation of terrestrial biodiversity to climate change

G. Midgley, (1)

(1) Stellenbosch University, Stellenbosch, South Africa

The rate and extent of projected anthropogenic climate change over the next century may be unprecedented in several million to even tens of millions of years. This perturbation to the climate system is occurring during an inter-glacial phase, which is a naturally warm phase in the context of the Pleistocene epoch, which prior to the Holocene Epoch of the past 12 000 years, has predominantly (more than 80% of the time) seen global temperatures of roughly 5°C cooler than the Holocene, and atmospheric CO2 levels of 180 to 200 ppm vs the 280 ppm CO2 of the Holocene prior to the onset of the Anthropocene. Scenarios of 500+ ppm CO2 and possible warming in excess of 3°C represent a fundamental ecological shock to terrestrial ecosystems globally, especially in the light of the much cooler planetary history of the Pleistocene. Nonetheless, ecosystems and their component biodiversity have been exposed to repeated warming and cooling cycles and have clearly coped with these, indicating the potential for substantial natural adaptive capacity, and inherent resilience.

One clear adaptive response has involved geographic range shifts, especially at higher latitudes in the northern Hemisphere where temperature exerts a dominant control on growing season, biome distributions, and the geographic distribution of species. This observation, together with observations of incipient range shift responses has led to the application of a paradigm largely of “passive” adaptive planning. That is, using projected geographic shifts of species in response to future change in the spatial planning of areas that anticipate the direction and preferred routes for range shifts to facilitate receptive landscapes. Under extreme scenarios involving high rates of climate change on flat landscapes with a high “climate velocity” more active approaches have also been explored, including assisted migration. A final safety–net approach of gene or seed-banking has also been proposed. Such approaches seem relevant to terrestrial species that are rapidly experiencing warming, and may reach levels that could exceed existential tolerance limits established during Pleistocene times.

Under these conditions, ecosystems respond according to changing disturbance rules, and not climate rules, and thus individual range shifts may be less important, but community effects may be more important as entire ecosystems may change their structure and function over large areas, thus changing habitat conditions for consumers, and indeed interacting with consumer responses. With future atmospheric CO2 projected to approach levels not seen for more than 20 million years, direct CO2 impacts may strongly influence ecosystem and habitat shifts due to changing fire regime and water use efficiency in water–limited ecosystems, potentially encouraging the re-establishment of more woody biomes. This opens the potential for active management response versus the passive landscape planning approach. Active management would involve strategic decisions about desired future states, and how to achieve these, e.g., with the use of fire and graze management responses.

Conservation practitioners could benefit by considering both active and passive adaptive strategies for biodiversity conservation, as both may have relevance, albeit with different emphases, in low and high latitude situations. Much can be learned from experience in active interventions long practiced in tropical and sub-tropical situations involving fire management, browse–graze manipulation, and translocation/reintroduction of animal species. An urgent effort is also required to understand the strength of the CO2 fertilization effect on water– limited ecosystems, and the potential of this process to transform the structure and function of fire and grazing– controlled ecosystems.

K-L3.4-03

Title not communicated

B. Vira

Abstract not communicated

L3.5 - Benefits of mitigation of climate change for coastal areas

K-L3.5.01

Benefits of mitigation of climate change for coastal areas

R. Nicholls (1)

(1) Tyndall Centre for Climate Change Research, Southampton, United Kingdom

This presentation will review the possible benefits of mitigation of climate change for coastal areas with a strong emphasis on sea–level rise. This is one of the most certain consequences of human–induced global warming and has significant impacts. Importantly, there is a long–term ‘commitment to sea–level rise’ due to the long thermal lags of the ocean system and hence the response of sea–level rise to mitigation is slower than for other climate factors. Therefore, while climate stabilisation reduces coastal impacts during the 21st century, compared to unmitigated emissions, the largest benefits may occur in the 22nd century (and beyond). While we cannot avoid high sea levels, we can still avoid significant losses of the Greenland and Antarctic ice sheets, with significant long–term benefits to coastal inhabitants. The available results suggest that a mixture of adaptation and mitigation policies need to be considered for coastal areas, as this will provide a more robust response to human–induced climate change than either policy in isolation. This point has been clearly articulated in coastal impact chapters of the Fourth and Fifth IPCC Assessments. This approach requires the joint evaluation...
of mitigation and adaptation in coastal areas which has not been systematically considered to date. Because of the long time constants involved such assessments need to continue beyond 2100 to provide the full implications of the different policy choices. While the basic science of the long-term consequences of global change is improving, the implications for adaptation and mitigation solutions, as well as knowledge networks on the regional scale, to face climate change effects. Rather than supporting local population to adapt to climate change, this long term applied research project aims to understand how indigenous peoples are engaged with the environment through their current management practices. The notion of life cycle, integrating both sociocultural and natural elements as privilege and methodology. Indigenous peoples have developed detailed and sophisticated knowledge on the ecological processes, which could improve a more rich and territorialized comprehension of ecosystem transformations and climate change. Since 2005 a collaborative research has been developed on the economic and socio-economic cycles in the Northwestern Amazon, a region of about 250000 square kilometers of officially recognized and demarcated indigenous territory at the border Brazil–Colombia. This cross-cultural and interdisciplinary research involves a team of indigenous and non-indigenous researchers, and methodologies aimed at an effective communication and collaboration between the indigenous knowledge and Western science. This initiative aims to: (1) describe the economic-ecological and socio-cultural pattern of indigenous peoples of the Amazon northwest, from observations and recordings done by the indigenous researchers over the years; (2) monitor the annual cycles, identifying and analyzing their patterns and variations, noting possible regional effects of more extensive climate change; (3) as a future perspective, guiding environmental governance policies of indigenous territories considering climate change scenarios; (4) propose ways and methodologies to monitor climate change from the collaboration between indigenous and scientific knowledge within the Amazon basin. Information and policies related to climate change commonly reach the local communities through biased and inappropriate ways, typically from top to bottom. This collaborative research, which emerged in the context of long-term partnership relations between regional indigenous organizations, ISAN (Regional Federation of indigenous organizations) and ISA (Socioenvironmental Institute), who jointly develop several projects in the areas of sustainable community development, capacity building etc. seeks an exchange of knowledge on annual cycles. It departs from a simple methodology based on daily written logbooks kept by indigenous dwellers (trained as researchers) from various communities along the same river (about 400 km long) and some of its tributaries, usually young adults. A growth for additional and then and interpretations with elder knowledge holders, about the phenomena they are observing. In addition, workshops are made to organize and discuss this material with researchers and advisers of ISA. The main assumption is the recognition that indigenous peoples inhabiting the same region for generations, even with direct effects of climate change on their own subsistence activities, are the ones who better know and understand the life cycles. This research process has accumulated extensive material that is being organized, edited and analyzed. This poster describes the annual calendar of the Eastern Tropical peoples, and highlights its relevance to decision-making. This research is on ecosystem and climate change on a regional scale and unfolding possibilities in terms of relevant public policies.

K-L3.5-02

Indigenous knowledge on ecosystem cycles in Northwestern Amazon: a collaborative research towards climate change assessment in a regional scale

A. Cabalzar (1)
(1) Instituto Socioambiental, Programa Rio Negro, São Paulo SP, Brazil

Tropical rainforests are of utter importance for ecological balance and climate stability on global scale. However, as widely reported, there is a growing threat to them and their traditional peoples, deforestation performing between 15 to 20% of the global GHG emissions. The Amazon forest is the largest rainforest in the planet. Indigenous peoples have a key role in the future maintenance of the Amazon biome, considering that 27.5% of the whole extension of the Amazon basin consists of indigenous territories – in Brazil the percentage is about 22% and in Colombia, it is higher than 50%. This shows significant interrelations between tropical forests, indigenous peoples and the climate change. The collaborative research initiative here described aims at joining the efforts of IPCC WG II, as stated in its Summary for Policymakers. This research project aims to address adaptation and mitigation solutions, as well as knowledge networks on the regional scale, to face climate change effects. Rather than supporting local population to adapt to climate change, this long term applied research project aims to understand how indigenous peoples are engaged with the environment through their current management practices. The notion of life cycle, integrating both sociocultural and natural elements as privilege and methodology. Indigenous peoples have developed detailed and sophisticated knowledge on the ecological processes, which could improve a more rich and territorialized comprehension of ecosystem transformations and climate change.

Since 2005 a collaborative research has been developed on the economic and socio-economic cycles in the Northwestern Amazon, a region of about 250000 square kilometers of officially recognized and demarcated indigenous territory at the border Brazil–Colombia. This cross-cultural and interdisciplinary research involves a team of indigenous and non-indigenous researchers, and methodologies aimed at an effective communication and collaboration between the indigenous knowledge and Western science. This initiative aims to: (1) describe the economic-ecological and socio-cultural pattern of indigenous peoples of the Amazon northwest, from observations and recordings done by the indigenous researchers over the years; (2) monitor the annual cycles, identifying and analyzing their patterns and variations, noting possible regional effects of more extensive climate change; (3) as a future perspective, guiding environmental governance policies of indigenous territories considering climate change scenarios; (4) propose ways and methodologies to monitor climate change from the collaboration between indigenous and scientific knowledge within the Amazon basin. Information and policies related to climate change commonly reach the local communities through biased and inappropriate ways, typically from top to bottom. This collaborative research, which emerged in the context of long-term partnership relations between regional indigenous organizations, ISAN (Regional Federation of indigenous organizations) and ISA (Socioenvironmental Institute), who jointly develop several projects in the areas of sustainable community development, capacity building etc. seeks an exchange of knowledge on annual cycles. It departs from a simple methodology based on daily written logbooks kept by indigenous dwellers (trained as researchers) from various communities along the same river (about 400 km long) and some of its tributaries, usually young adults. A growth for additional and then and interpretations with elder knowledge holders, about the phenomena they are observing. In addition, workshops are made to organize and discuss this material with researchers and advisers of ISA. The main assumption is the recognition that indigenous peoples inhabiting the same region for generations, even with direct effects of climate change on their own subsistence activities, are the ones who better know and understand the life cycles. This research process has accumulated extensive material that is being organized, edited and analyzed. This poster describes the annual calendar of the Eastern Tropical peoples, and highlights its relevance to decision-making. This research is on ecosystem and climate change on a regional scale and unfolding possibilities in terms of relevant public policies.

K-L3.5-03

Effective adaptation strategies and risk reduction to global changes in small farmers in Mesoamerica

A. Solano (1); E. Castellanos (1); C. Tucker (2); H. Eakin (3); J. Barrera (4); R. Diaz (5)
(1) Universidad Del Valle de Guatemala, Centro de Estudios Ambientales y de Biodiversidad, Guatemala, Guatemala; (2) Indiana University, Anthropology, Bloomington, IN, United States of America; (3) Arizona State University, Arizona, United States of America; (4) Colegio de la Frontera Sur, Tapachula, Mexico; (5) Universidad Nacional de Costa Rica, Heredia, Costa Rica

Mesoamerica is a region highly vulnerable to climate change because of its geographic location and topography. Moreover, high levels of poverty and social exclusion increase its population vulnerability. In recent years, the region has been severely affected by extreme weather events with high cost in casualties and economic impacts. A single event such as Hurricane Stan in 2005 produced an economic loss similar to the GDP increment for Guatemala for that year. Drought events are occurring more frequently and threaten food security for thousands of impoverished families who depend on subsistence agriculture. Coffee is an export crop that has been most affected in recent years not only by extreme weather events, but also by the economic crisis as a result of price volatility in the international market and more recently by the strong incidence of coffee rust infestation. Across Mesoamerica, over 4 million people depend directly on coffee production for their livelihoods. Most producers are farmers with limited areas of land and who usually have access to their system of production results in a robust agroforestry system, which provides various environmental services.

Our Global Changes and Coffee research program has been working with small farmers in the region for the last ten years to study the adaptation strategies of families whose livelihoods are strongly affected by global changes such as climate change, increase incidence of pests and diseases, and highly volatile international markets for their products. Our research has focused in four countries in Mesoamerica: Mexico, Guatemala, Honduras, and Costa Rica through the work of a multidisciplinary research network formed by scientists from the social and natural sciences.

In this paper, we will discuss results derived from three objectives of our research program: 1. Studying the perceptions of farmers to identify situations that affect their livelihoods; 2. Identifying the barriers that limit their efforts to adapt to a multi-stressor environment; and 3. Making recommendations for stakeholders at the local and national level working to support these farmers. Results show that most farmers who participated in this study perceive that there is a change in climate conditions, resulting in warmer days and changes in the seasonality of rains (change in the rainy season). Most producers are farmers with limited areas of land and who usually have access to the most important strategy adopted by farmers is diversification of both economic activities and cultivated crops.

Our research shows that there are significant barriers to adaptation among farmers: limited financial resources,
insufficient technical support, low availability of key information such as weather forecasts and market variations, and difficulty in keeping local organizations active.

Adaptation should be approached as a two-way process: top-down, with national-level decision-makers developing policies and programs to increase access to financial instruments, and to improve the dissemination of strategic information to local markets and climate variability. This should be complemented with a bottom-up approach that strengthens existing social capital in the form of local organizations and cooperatives, and increases the flow of knowledge from local communities involved in processes of autonomous adaptation to national government officials and decision makers.

K-L3.5-04

Impact of country-level policies on smallholder farmer adaptation to climate change in Sub-Saharan Africa

E. Nkonya (1); F. Place (2); E. Kato (2); M. Majaliwa (3)
(1) International Food Policy Research Institute, Washington D.C., United States of America; (2) International Food Policy Research Institute, Washington D.C., United States of America; (3) Makerere University, Kampala, Uganda

The overarching challenge of sub-Saharan Africa (SSA) governments is to design appropriate policies that will increase smallholder farmer uptake of climate-smart land and water management (CSLWM) practices. This study was done to determine impact of policies on farmer adaptation to climate change. The study used a transboundary approach in which communities with comparable biophysical and socio-economic characteristics but residing in two neighboring countries with different policies were used. The study shows that investment in agricultural research and development, strong land & tree tenure, decentralization and investment in smallholder irrigation are the key policies that enhance CSLWM uptake and adaptation to climate change. Additionally policies that provide incentives for tree planting and protection and that give mandate to local communities to manage natural resources are key strategies for enhancing uptake of CSLWM.

The study also found that government policies that provide incentives for long-term land investments are more important than large top-down public investments that ignore the role of farmers in planning and management of such investments.

K-L3.5-05

Achieving the Potential Contribution of Planted Forests to Adaptation to and Mitigation of Climate Change

J.M. Carnus (1); P. Freer-Smith (2); M. Tomé (3); P. Tim (4); T. Fox (5); W. Kollett (6); C. Orazio (7); J. Morison (8)
(1) INRA, Department of forest, grassland and freshwater ecology, Toulouse, France; (2) Forestry Commission, Forest Research, Farnham, United Kingdom; (3) Makerere University, Kampala, Uganda; (4) Scion, Rotorua, New Zealand; (5) Virginia Institute of Technology, Forestry, Virginia, United States of America; (6) FAO of the United Nations, Rome, Italy; (7) EFI, EFI ATLANTIC, cestas, France; (8) Forest Research, Centre for sustainable forestry and climate change, Farnham, United Kingdom

Globally, production and provision of ecosystem goods and services from planted forests are being altered by climate change. This poses new challenges to forest policy makers, local communities, forest managers, and the forest-based industries which depend increasingly on wood and biomass resources from planted forests. Planted forests can also be managed to make a major contribution to the removal of carbon from the atmosphere and hence the mitigation of climate change. Climate change adaptation strategies and recommendations for sustainable forest management have been developed at global or regional scales for planted forests in various environmental and socio-economic contexts, but these need to be complemented and further elaborated for implementation at local scales in close interaction with regional, national and local stakeholders. We will present territorial foresight approaches, landscape simulation tools, carbon budgeting and best practice case studies from planted forests in various temperate regions around the world. These can provide useful models and demonstrators on which to base management options to achieve effective future adaptation to and mitigation of climate change.

K-L3.5-06

Using seasonal forecasts to improve small farmers’ resilience and adaptation to climate change and food security in Yatenga northern Burkina Faso

L. Some (1)
(1) Institut de l’environnement et de recherches agricoles, Gestion des ressources naturelles, Ouagadougou, Burkina Faso

Agriculture in the Sahel is strongly dependent on rainfall; hence the urgent need to disseminate appropriate seasonal climate forecasts. Since 1998, researchers in several international and regional forecast centers help of experts from national meteorological services strive to provide answers. In June 2014, these predictions were compared with indigenous knowledge based on observations of certain signs, made by people in 11 villages of the AFS research site in Yatenga, Burkina Faso. These two types of prediction converged and gave a season rainfall deficit trend compared to the average observed over the last thirty years. Ten farmers managers in each of these villages, which produce cowpeas and / or sesame each received a radio to monitor weather information broadcast daily in local language and in French by a community radio station covering the area well. Yield squares were placed in their fields to an assessment of production. Meanwhile, ten farmers in six cities considered as control were also selected and their fields, followed in the same conditions as above.

The controlled experimental approach is to compare seasonal climate forecasts through the project and have not been endowed with radios. The results show excess rainfall totals to normal in the region, but badly distributed in time and space, causing dry spells in some localities. Preliminary agronomic results do not show significant differences between the two types of monitoring operations.

Key words: Productivity, sesame cowpea, climate forecasting, Yatenga, Burkina Faso

K-L3.5-07

Joint public and private finance for ecosystem-based adaptation - an example from nature-based coastal protection in Indonesia

K. Meijer (1)
(1) Deltares, Scenarios and Policy Analysis, Delft, Netherlands

Measures to adapt to climate change can have negative environmental impacts. For example, coastal flood protection walls prevent the influx of sediment and the natural build-up of coastal areas, while increased freshwater storage in reservoirs can lead to fragmentation of river ecosystems. However, adaptation can also be done with less impact on the environment, for example by restoring mangrove and other coastal ecosystems. Such adaptation strategies that make use of the natural functioning of ecosystem processes are referred to as ecosystem-based adaptation. Ecosystem-based adaptation can therefore be assumed not to have negative environmental impacts but rather to strengthen or expand ecosystems and protect biodiversity.

Developing countries may require financial support to adapt to the impacts of climate change. The international community has committed to providing 100 billion USD/year from 2020 to support adaptation in developing countries. With roughly half the amount to be spent on adaptation, large financial flows can be expected in the coming decades to support the implementation of adaptation projects in developing countries. Funds should come from both public and private sources; public funds should be used to ‘leverage’ private sector funds. Through the provision of finance, investors and donors may steer how adaptation is implemented. The question this paper addresses is whether ecosystem-based adaptation is, or can be made, as attractive to
investors and donors as conventional adaptation.

This paper starts with a discussion of the revenue-generating potential of ecosystem-based and conventional adaptation alternatives for different types of climate impacts. Subsequently, we analyze the case of nature-based flood protection in Indonesia, which is currently being implemented as an alternative for concrete breakwaters that have been used so far. We discuss economic benefits and (financial) incentives related to both options. We pay specific attention to the financial aspects of the nature-based flood defense, which is financed through a combination of international and national public, and international private funds. Based on the analysis of the case we provide suggestions for international public funds to further promote ecosystem-based adaptation solutions and to leverage private sector finance for this purpose, and provide a first check regarding to what extent such solutions are actively or passively promoted by a selection of current funds.

K-L3.5-08

Global change adaptation in the Llobregat basin: methodology and tool for medium and long term water resources planning

A. Cabello (1) ; L. Pouget, (1)
(1) cetaqua, Sustainability department, Cornellà, Barcelona, Spain

In recent years, water resources management has been facing new challenges due to increasing changes and their associated uncertainties, such as climate, water demand or land use. In this context, the Water Change project developed a methodology and a tool which can provide support to decision makers in assessing potential future impacts of global change on water resources and give guidance as to the effectiveness of possible strategies of adaptation.

The methodology focuses on the creation of global change scenarios, the analysis of impacts and the definition of adaptation strategies based on a cost-benefit analysis. The tool developed (Water Change Modelling System or WCMS) is a software-based system with a modular approach, linking different models (hydrological, water management and water quality models). The tool enables users to quantify the impacts of global change scenarios and test adaptation measures.

The methodology and tool were applied to the Llobregat river basin, a highly populated catchment under increasing water stress in the North-East of Spain. Impacts of global change scenarios on water supply were assessed for different time horizons and optimum adaptation strategies in terms of cost-benefit were proposed.

The user is free to choose the models to be run in the tool, and different scenarios of global change can be used as inputs, to assess the impacts on water resources (in terms of quality and quantity). Finally adaptation measures can be implemented to test their effectiveness. Including adaptation to global change in water resources management planning is quite challenging given the uncertainty of future predictions in terms of demand, climate and land use. The adaptation strategies chosen must minimise the risk at an affordable cost, taking into account all the scenarios which could occur at a given time horizon.

As mentioned in the Water Framework Directive, water management plans will have to include adaptation strategies taking into account the impacts of climate change on the water sector. In this context, the methodology and tool developed aim to provide support to decision makers in water management. The tool can be used in any basin and the methodology can be applied in order to evaluate different adaptation strategies, in terms of deficit reduction and costs involved. Thus water and basin agencies are likely to take part in the final product, and they could be identified through associations such as the INBO (International Network of Basin Organisation).

For the tested case study, a total of 65 scenarios of global change were developed and run using the WCMS. The possible future impacts on water resources and on the water supply of the basin were obtained and the results shows the range of impacts increases with time. According to the projections, in 2030 the deficit may reach 10% of the demand while in 2100 the deficit could reach 30% of the demand.

As a response to the impact foreseen different adaptation strategies which could be implemented in the Llobregat River Basin were proposed and assessed. Specific adaptation measures were selected to be applied to the Llobregat river basin. Each adaptation strategy was studied in detail and the amount of water gained from its application and the price of implementation were identified, with the aim to avoid water deficit at the lowest costs.

Each of these strategies was tested for several future scenarios with the aim to know which part of the drought damage has been effectively avoided and which cost (investment and operation of the measures) should be assumed. The inclusion of these alternatives into the tool and the calculation of their costs and benefits provided insight for decision-makers about how much adaptation is needed with respect to the uncertainty of future global change scenarios.

In the case of the Llobregat River Basin, the results showed benefits are significantly higher than costs and thus adaptation to Global Change is desirable. Regarding which strategy should be chosen, the decision-maker can apply different selection criteria, combining the economic values with other indicators of impact.

K-L3.5-09

Observations and guidance for land-based mitigation

M. Herold (1)
(1) Wageningen University, Wageningen, Netherlands

Progress in observations and the development of community consensus guidelines and training materials provide underpinnings for planning, implementation and evaluation of mitigations in the forest and agricultural sector. We review the observation needs from multiple stakeholders involved in mitigation and assess how the evolution of dedicated Sourcebook for REDD+ monitoring development Global Observations of Forest Cover and Land Dynamics (GoFC-GOLD) has supported developing countries. Important developments in the context of the Global Climate Observation Systems (GCOS) are increasingly improving the usefulness of monitoring Essential Climate Variables for climate change mitigation purposes.

L4.1 - The climate, finance and trade nexus: turning a political challenge into a sustainable development opportunity

K-L4.1-01

Upgrading finance and price signals in an adverse economic context

J.C. Hourcade (1)
(1) International Research Center on Environment and Development (CIRED), Paris, France

The current context of the world economy in the aftermath of the 2008 financial crisis makes difficult to implement a quickly rising carbon price to trigger ambitious low carbon transition (competitiveness issues, unemployment, political reluctance to transfers compensating the segments of population the most affected by higher energy prices).

This presentation will demonstrate that the emerging calls for upgrading climate finance will also confront this adverse context because of the tightness of public budgets. It will then propose to turn the question upside-down through
making climate finance a lever to upgrade the efficiency of the current financial intermediation in directing saving towards long term infrastructure investments. It will then display the basic principles of financial devices apt to a) lower the investment risks on low carbon projects based on an agreed upon notional value of carbon which can be increased at a pace higher than this of a carbon price b) redirect to these investments private savings which go currently in speculative investments and liquid financial products c) foster a sustainable growth recovery out of the current fragile economic context. It will conclude in showing how such a framework will a) reduce tensions due to the asymmetry of trade–impacts of carbon prices amongst sectors and countries b) fulfill the CBDR principle and c) increase the incentive efficiency of carbon pricing, hence its political acceptability.

K-L4.1-02

Using trade policy to ensure the viability of massive use of low carbon technologies

R. Meléndez-Ortiz (1)
(1) International Centre for Trade and Sustainable Development, Geneva, Switzerland

The recent IPCC-report clearly demonstrates the need to shift to a cleaner energy mix if we are to stay within the agreed 2-degree target of global temperature rise. In order to do so, costs of renewable energy must go down and markets need to be strengthened so as to allow for a scale-up of innovation, production and deployment of sustainable energy technologies.

Trade policy has an important role to play in this respect. Reducing tariffs and barriers to trade in services related to clean energy will make it easier for private actors to optimize their supply-chains, thereby pushing down costs. In order to further enhance trade opportunities it will also be necessary to address less tangible but nevertheless significant non-tariff barriers such as standards.

In the past few years, there has been a surge in the use of trade remedies in the area of clean energy. Whereas this to a great extent reflects a natural consolidation of the market with steeply falling prices, the pressure is strong on governments to put in place trade restrictions to protect its domestic industry. Similarly, whereas decision-makers across the world recognise the need to scale up clean energy at home, it can be challenging to put in place policies that may be perceived as costly unless there is an encouragement specifically for the domestic industry. This has led to the proliferation of trade restrictive policies like local content requirements, which demand that a certain amount of inputs in different clean energy projects be produced domestically.

Ironically, many of these trade restrictive policies maintain costs of climate-friendly technologies artificially high.

There are several options for addressing these trade obstacles. First, there are regional trade agreements—many of the world’s leading nations are currently involved in the negotiations of “mega-regionals” such as the T–TIP and the TPP. Second, there is a negotiation underway under a sectoral initiative aiming towards an Environmental Goods Agreement, EGA. Last, there is the option of unilateral trade reform.

The engagement and support of the climate constituency in these efforts would ensure a better alignment of trade policies with pressing climate change goals.

K-L4.1-03

Connecting emerging initiatives; the lessons for the UNEP finance inquiry

N. Robins (1)
(1) UNEP, London, United Kingdom

The UNEP Inquiry was launched in January 2014 to identify and advance policy options that can better align the US$300trn global financial system with long-term sustainable development. The Inquiry has worked through partnerships at the country level, Brazil, Colombia, France, India, Indonesia, Kenya, South Africa, Switzerland, the UK and the USA – as well as with international institutions. Its findings show that a growing number of governments, regulators, standard-setters and market actors are incorporating sustainability into the rules that govern the financial system. Across the Inquiry’s work, climate change has emerged as a key cross-cutting issue, and the Inquiry has recently published an emerging framework for linking financial reform and climate security. This framework identified four priority areas: risk management and prudential regulation; capital mobilisation; system transparency; and strengthening financial culture. Cutting across these priority areas, the strategic role of central banks has emerged as a critical theme. In this session, the Inquiry will present its findings, suggesting ways in which international cooperation could be strengthened.

K-L4.2-01

Climate change governance and Caribbean SIDS

M. Scobie (1)
(1) The University of the West Indies, Institute of International Relations, St. Augustine, Trinidad and Tobago

The analysis of governance of climate change is extremely important, more so for small island developing states: adaptation, mitigation, climate finance, governance architectures, environmental justice, equity etc. Despite a small proportion of the world, the peoples of these nations and their governance challenges are part of the global climate policy discourse. That said, the recent scholarly literature has focused on the science of climate change for SIDS, but there is less on the governance of climate change for SIDS in general and the Caribbean in particular. The science is clear. Adaptation is needed and urgently, yet the formula to make this happen is hard to come by. What would be a useful model for the climate governance architecture in the Caribbean SIDS region? The paper puts the results of the present science and future projections into the context of existing governance arrangements and looks at the weaknesses of the present system and how those may be eliminated to improve governance effectiveness. These issues are important for climate policy practitioners in SIDS and should also be at the forefront of the minds of academics, policy makers and practitioners in donor countries as they seek to engage in the analysis of the best models for effectiveness in climate governance, especially for SIDS.

While there are studies on the global dynamics of environmental governance, governance at the local level in SIDS, and in particular Caribbean SIDS has been neglected in the literature. Transnational climate governance is becoming more complex (Andonova, Betsill, and Bulkeley 2010), with a multiplicity of new actors, roles, structures and architectures of the earth’s governance (Bulkeley and Moser 2007). This fragmentation of global and local levels of authority are often a hindrance for climate change governance (Palmuoki 2013), the effectiveness, legitimacy and transparency of voluntary non-binding parallel streams of governance is under debate but reflects global engagement for governing climate change (Süsswea and Caplow 2011) and (Kalfagianni 2014). The challenge is to develop a global climate governance model...
that balances legitimacy and effectiveness while allowing participation from stakeholders (Dryzek and Stevenson 2011). This is particularly true as vulnerable small island developing states try to find a place in the global governance debate and to govern climate change in their countries.

As in every other area of governance, climate governance works where good governance is institutionally entrenched and political systems are climate governance is difficult where weak and under-resourced institutional arrangements are present. Environmental impacts of climate change increase the social, economic and environmental challenges and responses of governments. At the heart of effective climate change governance is the successful political coordination of adaptation and mitigation efforts from global to local scales by state and non-state actors (Frohlich and Knieling 2013). States and international organisations are responsible for at least a third of the initiatives (Hale and Roger 2014). The private sector has been heavily involved through private carbon certification schemes, emission trading markets and the Clean Development Mechanism (CDM) projects in partnerships with nation states (Lund 2013).

This research reviewed the 15 SIDS that form part of the Caribbean Community (CARICOM) and share mechanisms for climate change governance. Information on climate change impacts for the islands was obtained from semi-structured interviews with national and regional officials in climate change related posts. Secondary sources included reports and publications of multilateral development agencies, regional agencies and from the IPCC. The commonality of perspectives from the interviews was remarkable but not unexpected, key themes included: the institutions that provide the greatest support at national and regional level for climate change governance and their most important impacts/ contributions; the main sources of financing for climate change governance in the Caribbean and whether they were sufficient; challenges in application of funds; adequacy and effectiveness of regional mechanisms; whether time-bound project financing allowed for sustainable adaptation policies at the national level; alternative approaches for Caribbean states, and; what more is needed regarding global, regional and local climate change adaptation.

This paper investigates whether and to what extent global governance dynamics for climate change resonate in small states. It argues that the Caribbean climate change problem is both a resource problem and a governance problem. States have limited resources due to pre-existing development challenges and insufficient external support given the unsustainability of the traditional project based financing model of climate governance. These small states face huge environmental changes that they cannot influence by weak governance architectures to respond to this new threat to development.

K-L4.2-03
Transformative solutions in two Caribbean Insular Territories Under Climate Change Pressure: How can we reach Resilience targets? Climate Governance in two non-independent Caribbean Insular Territories: two different paths?

J. Piam (1)
(1) Centro de Investigacion, Caribbean islands, Puerto Rico

This contribution shows how two non-independent islands of the Caribbean reflect the dynamics of climate governance in their respective territories. For Puerto Rico, the approach and solutions adopted are best understood against the background of USA climate governance, while in the case of Guadeloupe governance arrangements are more aligned with climate change governance in France and Europe. This theme is explored with reference to case studies on the first wind energy projects implemented in both Guadeloupe and Puerto Rico, and other renewable energy initiatives introduced since 2009.

We explore the differences in approach to climate change issues in the two islands by analyzing the perceptions and attitudes of residents living near the wind farms, as well as the local press. While reflecting internationally accepted approaches to adaptation and mitigation and those of the Metropole, Guadeloupe and Puerto Rico may be considered potential "experimental laboratories" for developing transformative solutions, whose experience may be transferred to other island territories, and even to the Metropole. A brief analysis of the overall contribution of appropriate renewable energy development to the building of resilience to climate change in these islands, is also presented.

K-L4.2-04
Innovative climate financing in Small Islands Developing States (SIDS)

V. Fayolle (1)
(1) Acclimatise, Oxfordshire, United Kingdom

Acclimatise has worked in over 50 countries assessing the risks arising from a changing climate advising international, national and sub-national governments, NGOs, development partners and business and financial services sectors. Drawing on our experience and observations from published sources this presentation will explore a theme which we believe is a significant driver and enabler in delivering transformative solutions.

The role of the ‘private sector’ in resilience building and adapting to climate change remains an area which has received too little attention. Most SIDS operate on a market based economy in which the private sector directly and indirectly is the largest contributor to a country’s GDP. However the scope of national adaptation planning, the vulnerability of institutional systems and climate governance base; and the recognition of the sector’s role in providing and delivering solutions is rarely explored.

This is not helped by using a technical ‘adaptation language’ during engagement which has little relevance to those in the sector and treating the ‘private sector’ as a homogeneous group. Within many governments the climate change portfolio is ‘owned’ by Ministries with environmental or natural resource based departments. These Ministries are usually under-funded and have limited political influence within governments. This in turn, constrains their ability to influence decision making, national budget setting and prioritisation, and ultimately in delivering transformative change working with the private sector. If we are to respond to the climate change challenge then we need to see (in both developing and developed countries) the resilience and adaptation portfolio passing to where the power is: finance, national planning and the offices of Prime Ministers or Presidents.

K-L4.2-02
Creating the conditions for transformative action – mobilising the private sector in SIDS

J. Firth (1)
(1) Acclimatise, Newark, United Kingdom

Acclimatise has worked in over 50 countries assessing the risks arising from a changing climate advising international, national and sub-national governments, NGOs, development partners and business and financial services sectors. Drawing on our experience and observations from published sources this presentation will explore a theme which we believe is a significant driver and enabler in delivering transformative solutions.

The role of the ‘private sector’ in resilience building and adapting to climate change remains an area which has received too little attention. Most SIDS operate on a market based economy in which the private sector directly and indirectly is the largest contributor to a country’s GDP. However the scope of national adaptation planning, the vulnerability of institutional systems and climate governance base; and the recognition of the sector’s role in providing and delivering solutions is rarely explored.

As part of a joint effort to mobilize US$100 billion per year by 2020 from both public and private sources to address both the adaptation and mitigation needs of developing countries, a new global financing mechanism was established: the United Nations Green Climate Fund (GCF). Great expectations are being placed on the recently capitalised GCF: The GCF shall meet ambitious goals in terms of promoting a “paradigm shift towards low-emission and climate-resilient development” through innovative pathways by providing support to developing countries to limit or reduce their greenhouse gas emissions and to adapt to the impacts of climate change” with a special emphasis on adaptation in SIDS, Least Developed Countries and Africa as well as mobilize funds at scale in particular through private corporations, recognising that in the context of strained government budgets the private sector accounts for 70 to 85% of total global investments.

Against this backdrop, the GCF’s Private Sector Facility
aims to play a key role in promoting participation of private sector actors in developing countries, with a special emphasis on domestic private sector actors and adaptation (recipients of funding). However, the specific modalities to achieve this still need to be defined. If the CCF is to scale up private investments in building climate resilience in SIDS, it is essential that it reflects up on the experience in a SIDS context gained by existing multilateral and bilateral climate initiatives, such as the World Bank’s led Pilot Programme for Climate Resilience (PPCR) in the Caribbean and Pacific, that deploy concessional resources using a programmatic approach.

**L4.3 - Regional Perspectives on Low Carbon Pathways: exploring the conditionalities for climate resilient and equitable development**

**K-L4.3-01**

**Regional Perspectives on Low Carbon Pathways: Exploring the conditionalities for climate resilient and equitable development with examples from India**

J. Roy (1)

(1) Jadavpur University, Jadavpur, India

It is beyond debate now that future ‘global’ stabilization target is fundamental to manage climate change, impacts and associated risks. Mainstream debate is around the need to coordinate the national goals with global agenda. National autonomy argument in fragmented world is dominating. Also national priorities vary depending on relative speed and level on growth trajectories.

Low Carbon Pathways: Even though India has much lower per capita emissions, growth pattern of economic activities including energy supply sector are going to experience very high growth rates in coming decades. With a National Action Plan on Climate Change (NAPCC) in place since 2008 a number of actions are in place. Top down global model estimated with India specific sectoral parameter show what additional widespread actions are needed. This clearly shows need for much larger actions: policies, technology deployment, institutions and capacity building are needed. Cross sectoral implications show need for transformative change in energy supply system. Bottom up study at national, state and city level help in identification of sector specific low carbon growth potential of multiple options compared to base year emissions. Potential is high in energy supply sector, buildings sector and agriculture sector with relatively low potential in industry sector which has made much progress in the past and transport sector has huge challenges. Looking into the issue from investment need perspective the sectoral distribution gets reversed. Industry sector where low hanging fruits are already harvested, high cost options are awaiting deployment. Genuine concerns exist on the technical cost/ investment /system change. The cost effective solution list might not be the easiest to implement based on public acceptability, market entry barriers, existing policy vacuum, technical and institutional capacity available.

Resilience : Impact and Adaptation to develop a climate change proof development trajectory is much in discussion in India also evident from National Action Plan. Many adaptation needs in India e.g. flood management, a system of heat and cold related health safety systems, water system security, food security systems will enhance

**L4.4 - Multilevel Governance of Climate Change - New Strategies for Coordinating Policies on Mitigation and Adaptation**

**K-L4.4-01**

**The Emergence of new structures for global governance: will 'bottom up' actually work?**

D. Victor (1)

(1) University of California, San Diego, United States of America

With the failure of integrated, top-down bargaining strategies, analysts and diplomats have turned to bottom-up methods such as “building blocks” and “climate clubs” to coordinate national climate change policies and to avoid persistent diplomatic deadlock. Decomposition of the grand problem of climate change into smaller units is
Delivering ambitious climate action and the role of multilevel governance

J. Corfee-Morlot (1)
(1) OECD, Paris, France

This presentation presents a framework for multilevel governance, showing that advancing governance of climate change across all levels of government and relevant stakeholders is crucial to avoid policy gaps between local action plans and national policy frameworks (vertical integration) and to encourage cross-scale learning between relevant departments or institutions in local and regional governments (horizontal integration). Vertical and horizontal integration allows two-way benefits: locally-led or bottom-up where local initiatives influence national action and nationally-led or top-down where enabling frameworks empower local players. The most promising frameworks combine the two into hybrid models of policy dialogue where the lessons learnt are used to modify and fine-tune enabling frameworks and disseminated horizontally. Achieving more efficient local implementation of climate strategies. Such integration generates benefits at all stages of the policy process. This includes agenda setting and strategic planning, to encourage political leadership andIdentification of policy makers’ support; policy formulation and approval to promote long-term vision and near term action; local implementation to overcome obstacles, build necessary capacity, and establish reliable financing for action. Feedback and evaluation; and dissemination to promote information sharing and cross-scale learning.

A review of current practices suggests the need for national governments to create a sound institutional foundation and knowledge base to support decision making and action at local levels. National governments are also essential to help deliver financial resources to support local action. Key tools include harmonized GHG inventory methods for local government use and climate risk screening and mapping tools. Institutions designed to promote learning and adaptive capacity making include establishment of regional science-policy centres or ‘boundary’ organisations, often located in academic institutions, to provide locally-relevant scientific and other evidence to inform decisions taken at a subnational level. This evidence base can help governments to scale up climate action and to find cost-effective climate policy solutions to drive low-carbon, climate resilient development. It will also help national governments to deliver on ambitious climate policy goals in the coming decades.

K-L4.4-02

Climate governance in Latin America: Case studies of Brazil, Chile, Colombia and Peru

A. Rudnick (1); L. Rebollo (2)
(1) MAPS Programme, Latin America, Santiago, Chile; (2) Poch Ambiental S.A., Santiago, Chile

Since 2007, there has been an increase in government institutionalization of climate mitigation actions, and many of these efforts are relatively recent and in design or early implementation stage. This presentation draws on literature from developing countries that evaluates this institutionalization. It is important to monitor this trend closely to evaluate if policies and institutions created are sufficiently strong and effective to lead to the reductions required (Wakking group III, chapter 15, AR5 IPCC).

The institutional arrangements case studies aim at describing and documenting the governance related to climate change within MAPS Latin American countries (Brazil, Chile, Colombia and Peru). A case study per each country (Brazil, Chile, Colombia and Peru) will be conducted to describe and document, from a practitioner’s perspective, the state of the play of the institutional approaches in each country. The results can be useful for other developing countries when examining and enhancing their institutional structures.

The research questions that the country case studies aim to answer are:

- What institutional arrangements exist in MAPS LAC countries (Brazil, Chile, Colombia and Peru), at a public and national level, to address climate change?• What institutions related to climate change mitigation (and adaptation if information is available) exist? • How are decisions taken at a national and subnational level?• Are the decisions and actions legally binding? How climate change decisions are institutionalised or implemented?• If there is information available about how climate change is institutionalised in the private sector, local government and NGO(s)?• How have MAPS processes benefited from certain institutional arrangements? Has there been any changes or additions in the institutional arrangements as a result of MAPs processes or during MAPs processes? Has there been collaboration among MAPS LAC countries to share and learn from certain institutional arrangements?

Note: Mitigation Action Plans & Scenarios (MAPS) is a collaboration amongst developing countries to establish the evidence base for long-term transition to robust economies that are both carbon efficient and climate resilient. These processes involve high-level stakeholders in countries’ research priorities, design and development of MAPS LAC countries’ scenarios for their countries. For more information on the Mitigation Action Plans Scenarios Programme see www.mapsimprovement.org

K-L4.4-04

Coordinating adaptation between the municipal and local level: building adaptive capacity of resource poor communities in South Africa

G. Ziervogel (1)
(1) University of Cape Town, Environmental and Geographical Science, Cape Town, South Africa

It has been acknowledged that much adaptation to climate change occurs at the city, municipal and community scale. At this local level, both government and local communities need to take action. Both groups need to strengthen their adaptive capacity and their ability to interact with each other particularly in the face of shocks and stress, as experienced through climate change, resource depletion, economic volatility and increasing inequality. This paper draws on the experience of the FLOW Programme (Fostering Local Well-being). This is a transdisciplinary research project based in the Bergriver Municipality, in the Western Cape that seeks to build adaptive capacity of resource poor community members and strengthen their interaction with the municipality. We suggest that individual’s adaptive capacity is dependent on three interdependent dimensions, namely, 1) the development of social cohesion, 2) self-determination, and 3) connection to life-support systems. The paper will explore how the three dimensions that engender adaptive capacity have been built in the case study site. Specifically, the project has worked with youth ambassadors, local entrepreneurs and the local municipality using a range of interventions including participatory community mapping, resource flow mapping, personal and collective reflective practices, storytelling skills through video journalism, and introducing community currencies. The paper will interrogate the extent to which these interventions have built adaptive capacity and the importance of including this type of work in future climate change adaptation and transformation responses.

Other authors: Anna Cowen and John Ziniades
L4.5 - Equity: A Condition to Triggering Action?

**K-L4.5-01**

**The necessary role of ethics and justice in climate policy**

S. Caney (1)

(1) University of Oxford, Oxford, United Kingdom

The talk will cover three points:

1. Justice and the target of climate policy. First, it is often argued that climate policies should avoid ‘dangerous anthropogenic interference’ (UNFCCC Article 2). Specifying what constitutes a ‘dangerous’ climatic changes necessarily requires the use of normative criteria, and cannot be settled solely by scientific analyses of the effects of climate changes. Determining what the goal of climate policy should be requires policymakers to decide what changes, if any, are acceptable, and which are not and call for action; and this requires ethical criteria and an appeal to ideas of justice. I argue that on any plausible ethical criteria even a 2C goal permits dangerous climatic changes, and that recent calls to move away from the 2C target are misconceived.

2. Just burden sharing. A second criterion of a just climate policy is that the burdens of combating climate change (including the costs of mitigation, adaptation and compensation) are shared equitably. Many appeal to the doctrine of ‘common but differentiated responsibility’. I argue that this requires the endorsement of both a polluter pays principle and an ability to pay principle, and suggest how they should be combined.

3. My first two points emphasise the need for principles of justice (in both specifying what should be the target of climate policy and how burdens should be shared). My third point draws on this to emphasise the importance of transcending a pure Cost Benefit Approach for evaluating targets and policies.

**K-L4.5-02**

**Analysis of equity (including as related to ambition) in submission of INDCs**

D. Waskow (1)

(1) World Resources Institute, Washington DC, United States of America

The preparation of Intended Nationally Determined Contributions (INDC) is an important opportunity for countries to provide information about how their contributions are equitable. The COP decision agreed at Lima invites each country to describe in its INDC its contribution is “fair and ambitious, in light of national circumstances, and how it contributes towards achieving the objective of the Convention as set out in its Article 2.” A description of equity should include the use of a holistic set of quantitative and qualitative indicators that provide the international community and domestic stakeholders with essential information that includes emissions responsibility, capabilities (including economic and development capabilities), vulnerability and capacity to adapt, potential to act, and co-benefits of action. The information provided can be applicable to both mitigation and adaptation components of INDC. The INDC should also address how the INDC contributes to the global level of ambition for emissions reduction and collective effort for adaptation. Providing robust information and a narrative concerning equity can provide enhanced transparency, enable comparison of contributions among countries, increase international understanding of what is equitable in the context of specific national circumstances; and enable linkages of the contribution with national sustainable development objectives. Doing so can generate constructive discussions both within and among countries about equity and motivate increased and more equitable collective action. Annex I countries have thus far provided information on equity in their INDCs.

**K-L4.5-03**

**Equity in the 2015 Agreement**

X. Ngwadla (1)

(1) Council for Scientific and Industrial Research, Pretoria, South Africa

The inclusiveness, durability and effectiveness of the 2015 Agreement largely hinges on how questions relating to equity, and/or perception of fairness by Parties to the UNFCCC are achieved by the agreement. The diversity of the basis for making a judgement of what is fair has translated into a false dichotomy of qualitative vs quantitative treatment of equity in the agreement. The second dichotomy has been created in terms of options for national vs international discipline in the application of a common framework for addressing equity.

In Ngwadla & Rajamani, (2014) proposals and options for addressing the divergences on the technical and legal options for operationalising and Equity Reference Framework (ERF) in the 2015 Agreement. The ERF is framed on the determination of the required global effort and a determination of relative fair contributions by Parties, covering both mitigation and adaptation in its definition of the required effort. Its application and reflection in the agreement presents flexibility in both ‘top-down’ and ‘bottom-up’ or hybrid approaches in a global agreement.

Several other tools and approaches have proposed for apportioning mitigation responsibility based on a variety of metrics. The ERF is however premised on an envelope of metrics for historical contribution to emissions, capability of countries to respond, and development needs, as such outcomes are presented in a range and median of relative fair efforts by Parties. The envelope of metrics could be informed by the various proposals and metrics, including those various parties have presented as part of equity information in their INDCs.

The strength of the ERF further lies in its ability to be applied in different architectural and legal options, as it can be reflected as an integral part of the agreement, however couched in a language that reflect concerns pertaining to prescriptiveness and sovereignty of states. At the other end of the spectrum of options, it could be expressed as an external process through a declaration and run representative external organisations, with a view of providing a moral pull for fairness in the agreement.

In pursuit of a durable agreement, and that present day political realities do not confine the agreement coming into effect in 2020, several options still remain to have enabling provisions for an ERF kind of approach, taking into account options for aggregate application of such a framework, as well as self-application of such a multilaterally agreed framework.
ABSTRACT BOOK

K-1101-01
Man versus Climate: what we learn from paleodata on the vulnerability of tropical ecosystems

AM. Lézine (1) ; S. Ivory (2) ; F. Bassinot (3) ; C. Hély (4) ; P. Bracnot (5)
(1) LOCEAN, Paris, France; (2) Institute at Brown for the Study of Environment and Society, Brown University, Providence, United States of America; (3) Laboratoire des sciences de l'Evolution, isem umr cnrs 5554, lse, University of Montpellier, Montpellier, France; (4) Laboratoire Climat et de l'Environnement/IPSL, CEA-CNRS-UVSQ - UMR8212, CEA-CNRS-UVSQ - UMR8212, France; (5) Institut des Sciences de l'Evolution, Isem umr cnrs 5554, Ird 226, université de montpellier, ephe cirad, Montpellier, France; (5) LCSÉ-IPLS, Gif-sur-Yvette, France

The timing and amplitude of the end of the Holocene humid period and the transition toward of the present day arid/semi-arid conditions in the northern tropics has been the subject of multiple debates involving many scientists from both model and data communities. Several scenarios have been developed to discuss the abrupt or gradual character of this period and to identify the forcings at work. These debates have mostly focused on regions under the Atlantic and Indian monsoon systems at the northern edge of the Sahara Desert. However, the diversity of plants can affect the strength of biogeophysical feedback. Regions rich in plant diversity may stabilize the system leading to more gradual transitions. As alternative hypothesis, abrupt changes may also emerge from intrinsic threshold behaviour of hydrological systems and ecosystems. Finally, an assessment is made to which extent abrupt climate and vegetation changes in this region are likely to happen in the future.

K-1101-03
High-resolution paleolimnology opens new management perspectives for lakes adaptation to climate warming

M. Perga (1) ; V. Frossard (2) ; J.P. Jenny (1) ; B. Alik (1) ; F. Arnaud (3) ; V. Berthon (1) ; L. Domazion (1) ; C. Giguet-Covex (3) ; M. Magny (4) ; M. Manca (5) ; A. Marchetto (5) ; L. Millet (4) ; C. Pailles (6) ; C. Pignol (3) ; J. Poulenard (3) ; J.L. Reyss (7) ; F. Rimet (1) ; P. Sabatier (3) ; S. F. Sylvestre (8) ; V. Verneaux (4)
(1) INRA, UMR CARRETEL, Université Savoie-Mont-Blanc, Thonon les Bains, France; (2) UMR CARRETEL, Université de Savoie-Mont Blanc, Chambéry, France; (3) EDYTEM, Université de Savoie-Mont Blanc, Chambéry, France; (4) UMR Chrono-Environnement, Besançon, France; (5) CNRS-IRSE, Verbania-Pallanza, Italy; (6) Aix-Marseille Université, CNRS, IRD, UM34 CEREGE, Européole de l’Arbois, Aix-en-Provence, France; (7) LCSÉ, Gif sur Yvette, France; (8) Institut de Recherche pour le Développement, CEREGE, Aix-en-Provence, France

Varved lake sediments provide opportunities for high-resolution paleolimnological investigations that may extend monitoring surveys in order to target priority management actions under climate warming. This paper provides the synthesis of an international research program relying on 150 years-long, varved records for three managed perialpine lakes in Europe (Lakes Geneva, Annecy and Bourget). The dynamics of the dominant, local human pressures, as well as the ecological responses in the pelagic, benthic and littoral habitats were reconstructed using classical and newly developed paleo- proxies. Statistical modelling achieved the hierarchization of the drivers of their ecological trajectories.

All three lakes underwent different levels of eutrophication in the first half of the XXth century, followed by oligotrophication. Climate warming came along with a 2°C increase in air temperature over the last century, to which lakes were unequally thermally vulnerable. Unsurprisingly, phosphorous concentration has been the dominant ecological driver over the last century. Yet, other human-influenced, local environmental drivers (fisheries management practices, river regulations) have also significantly inflected ecological trajectories. Climate change has been impacting all habitats at rates that, in some cases, exceed those of local factors. The amplitude and ecological responses to similar climate change varied between lakes, but, at least for pelagic habitats, rather depended on the intensity of local human pressures than on the thermal effect of climate change. Deep habitats yet showed higher sensitivity to climate change but substantial influence of river flows. As a consequence, adapted local management strategies, fully integrating nutrient inputs, fisheries management and hydrological regulations may enable mitigating the deleterious consequences of ongoing climate change on these ecosystems.

O-1101-01
The Mediterranean Basin in a warmer and drier world: what can we learn from the past?

J. Guiot (1) ; D. Kaniiewski (2)
(1) CNRS, CEREGE, Aix-en-Provence, France; (2) University of Toulouse 3, Ecolab, Toulouse, France

Since the late-nineteenth century, surface temperatures have non-uniformly increased worldwide. The drawbacks of the global warming in drylands, such as in the Mediterranean, may become a main source of concern
in a near future, as it is often accompanied by increased droughts, that will severely degrade water supply and quality. History shows that access to water resources has always presented a challenge for societies around the Mediterranean throughout the Holocene (roughly the last 12,000 years). Repeatedly, adverse climate shifts seem to have interacted with social, economic and political variables, exacerbating vulnerabilities in drier regions. We present a reconstruction of the Holocene climate in the Mediterranean Basin using an innovative method to extract pollen data, using a Bayesian framework. This model inversion is particularly suited to deal with increasing dissimilarities between past millennia and the last century, especially due to a direct effect of CO2 on vegetation. The comparison of far past and last century shows that the intensity of century-scale precipitation fall, amplified by higher temperatures and then evapotranspiration, is unmatched over the last 10,000 years. The recent climatic change is then unprecedented during the last 10,000 years in the Mediterranean Basin. We show that adverse climate shifts are often correlated with the decline or collapse of Mediterranean civilizations, particularly in the eastern Basin. The main consequence is that, over the next few decades, Mediterranean societies are likely to be much more critically vulnerable to climate change, than at any dry period of the past.

Long-term ecological dynamics of an alpine lacustrine ecosystem during the Holocene in the French Alps (Lake Petit, 2200 m a.s.l.): regime shift and resilience of algal communities

R. Cartier (1)

(1) Aix–Marseille Université, CNRS, IRD, Collège de France, UM 34 CEREGE, Aix-en-Provence, France

Multidisciplinary investigations on lake sediments in the Mediterranean Alps enable tracking back the dynamics of lacustrine ecosystems as well as their response to human activities and climate change. Such external forcing may lead to a variety of lake responses, ranging from gradual changes to sudden regime shifts. Sediments from Lake Petit (2200 m a.s.l., Southern French Alps) were particularly relevant for a coupled palaeoecology of landscape and algal communities. This overall stability was suddenly interrupted at 4200 cal. BP by a major detrital pulse that triggered a drop in diatom productivity and diversity probably climate–linked with the “4.2 ka event”;

- From 4800 to 4300 cal. BP, Lake Petit was a stable diatom productive water body dominated by alkaliphilous diatoms. Nutrients were supplied by the chemical weathering of podzols that developed under conifer woodlands. This overall stability was suddenly interrupted at 4200 cal. BP by a major detrital pulse that triggered a drop in diatom productivity and diversity probably climate–linked with the “4.2 ka event”;

- From 4100 to 2400 cal. BP, diatom productivity decreased whereas the algae Pediasstrum developed. Diatom assemblages subjected to terrigenous inputs from continuous erosion of pasture soils, were more diversified;

- Finally, from 2400 cal. BP to the present day, diatom assemblages reveal a slight acidification and nutrient enrichment of waters concomitant with increasing human pressure in the catchment.

Results obtained at Lake Petit provide a good example of abrupt regime shift in mountain systems in response to rapid climatic event, and further by incremental change triggered by human activities beyond critical threshold.

How humans feed flood: lessons from the past

E. Brisset (1); F. Guitter (2); C. Miramont (1); T. Troussier (2); Y. Poher (2); E. Anthony (1)

(1) Aix–Marseille Université, CNRS, IRD, Collège de France, UM 34 CEREGE, Aix-en-Provence, France; (2) Aix–Marseille Université, CNRS, IRD, UMR 7263 IMBE, Aix-en-Provence, France

Future projections on alpine climate changes suggest that more hydrological extreme can be expected to increase the river flood risk in this region. During mountain–river floods, the amount of sediment rushing down slopes constitutes a threat for society, burring floodplains and devastating people and infrastructures. This hydro-geological phenomenon poses hazards in mountainous areas of the world because they occur on steep slopes having abundant sediment available. By promoting land degradation, human are susceptible to modify the sensitivity of landscapes to natural hazard. As a result, it is crucial to investigate how humans have transformed geomorphic response to river flood on historic timescale, and what this means for our present and future. Here we explore since when mountain–river flood are linked to human agencies and to what extent man influence nature.

To address these issues, we examined the geomorphic response during flood events to vegetation cover and land–use changes over the last 7400 years for a large mountain lake of the European Alps, the Lake Allos (44°14’N, 6°42’35”E, 2230 m a.s.l.). Indeed, the sediments of the Lake Allos are a reliable geological archive to reconstruct flood deposits calendar over long time scale as their suspension load produce a distinct detrital layer contrasting to background sedimentation allowing their identification, counting and dating.

Our results show that the progressive increase in human activities (domestic livestock grazing) was not followed by a progressive increase in erosion at Allos. At 2000 cal. BP, the flood record showed an abrupt transition in sediment load and in event frequency which have been multiplied by a factor of four. Since this date, precipitations of higher intensity were able to mobilise and transport larger sediment amount. Precipitation of lesser intensity were more frequently able to trigger sediment inputs.

These results indicate that a threshold in the sensitivity to erosion in the source area were attained due to several millennia of human pressure. These results also argue that humans, by changing sensitivity of landscapes for their activities, have considerably amplified geomorphic responses to natural hazards.

Interdisciplinary and transboundary work to rebuilt extreme hydrological events in the Rhine Graben (France – Germany – Switzerland) during the last six centuries (TRANSISK and TRANSISK® Programs)

B. Martin (1); R. Glaser (2); F. Giacosa (1); N. Holleville (1); I. Himmelsbach (2); B. Furst (1); J. Schönbein (2); L. With (1); P. Wassmer (3); MC. Vitoux (1)

(1) CRESAT, Université de haute – alsace, mulhouse, France; (2) Institut für Physische Geographie, Albert ludwig university, freiberg, Germany; (3) Laboratoire de Geographie Physique, Université paris 1 pantheon–sorbonne, paris, France

The Franco – german projects TRANSISK (2008 – 2011) and TRANSISK® (2014 – 2017) have made it possible to elaborate a comparative chronology of the floods in the area of the Upper Rhine over a long period (1480 – 2015), paying attention to the description of the events (characteristics, climatic and human causes, consequences) as well as to the management by those in charge at the local scenes of the risk. The objective was to understand the evolution and to model complex causal factors at all scales, particularly between France and Germany. This interdisciplinary work (historians, geographers, anthropologists, sociologists, linguists) has been done by researchers from Germany and France on both side of the Rhine between Basel and Strasbourg. The interest of that
research is twofold:

- It is carried out on a territory which is limited and relatively homogeneous, but divided by borders between three nations, Switzerland, France and Germany, and these borders have been three times at war between 1870 and 1945.

- It is really concerning a major state of territorial management: the prevention of floods, a hazard not well known in its spatio-temporal characteristics on account of the wars and of the many political and administrative changes that this territory has gone through.

The researches in the archives have thus made it possible to establish a database including over 3,000 events related to the floods between 480 and nowadays involving the Rhine, and 13 tributaries on both side on the border. The most important of those floods have been mapped, classed and compared, revealing at the end a real individuality of flood and the need of building new flood scenarios for the future. That's why these research programs are involved into many actions of flood risk management, concerning, for example, memory and risk culture, as well as modelling of extreme events in a historic – progressive approach.

About scenarios, if no pattern of coherent and synchronized evolution is available for the reconstruction of the underlying climatic conditions permits to determine 4 broad types of situations favorable to flooding in that area. And, facing an extreme situation that has already occurred in the past, the first need of prevention, nor the people are really prepared. That's also the reason why we have developed a website (linked to social networks) to share information on historical floods (www.orrion.fr), even if floods need a real contextualization and risk culture, as well as modelling of extreme events in a historic – progressive approach.

But the chronologies demonstrate, on the one hand, the importance of conditions on a local scale, and, on the other hand, the aggravating or lessening role of human factors. They generate variations in time and space of the vulnerability to floods, which are manifest on different scales, revealing in particular a real ‘borderline effect’ between France and Germany.

What those studies also point out, however, is that the fight against floods has been at all times the manifestation of political will, mostly a reaction to disaster, and thus has been constantly re-defined in any context of important changes in the political structures. This is of course a lesson for the future.

1101-POSTER PRESENTATIONS

P-1101-01

Learning from the Past to understand the Presente and predict the Future: The Mexican Quaternary Mammal Database

J. Arroyo-Cabrales (1) ; I. Ferrusquia-Villafranca (2) ; E. Johnson (3) ; J. Ruiz-González (2) ; E. Martínez-Hernández (2) ; J. Gama-Castro (2)

(1) INSTITUTO NACIONAL DE ANTROPOLOGÍA E HISTORIA, MÉXICO, D. F., México; (2) UNIVERIDAD NACIONAL AUTÓNOMA DE MÉXICO, Instituto de geología, MÉXICO, D. F., México; (3) MUSEUM OF TEXAS TECH UNIVERSITY, Department of anthropology, LUBBOCK, TEXAS, United States of America

The Pleistocene and modern mammal faunas of southern North America partially differ in taxonomic composition, distribution, and physiognomy. The former faunal complexes are part of the ancient landscape in which early people may have interacted. Differences between the Pleistocene and modern faunas have been attributed either to climate change, to human–impact driven extinctions, or even to catastrophic phenomena, like a meteorite impact. Mexico’s Pleistocene mammal record is analyzed in time and space, emphasizing the study of the Rancholabrean Chronofauna. Furthermore, a radiocarbon dating program, tMVB province and mammoth would be a reasonable target. The most concentrated research in the Northern provinces has been most fruitful and inside the country. This approach supports an explanation for the differences between southern North America’s Pleistocene and modern mammal faunas. This difference is the combined results of all species extinctions and range modifications that affected and changed the vertebrate biota physiognomy and taxonomic composition. The available fossil record, however, does not portray this major biogeographic shift in detail due to the lack of associated chronometric data. The analysis of disjunct (i.e., separated from the main range) and of demonstrably relict species may be an alternative to provide greater details and understand the response of individual species to climate change during the Late Pleistocene. The Late Pleistocene mammal record was analyzed by morphotectonic provinces that were grouped into smaller geographic units. The extent, distribution, any variance in distribution (extinctions, extirpations), and environmental conditions inferred from that distribution and variance. Time and space biases exist, consisting of the continuous eight sister states. The region and the Trans–Mexican Volcanic Belt (TMVB), particularly the Basin of México. Nevertheless, biological communities throughout the country experience profound changes in species composition and structure. Such a pattern was due not to direct human impact but to the consequences of environmental changes throughout and particularly at the end of the Pleistocene. The shifting of ecological and climatic zones was not a simple matter of displacement and range adjustments. Such conditions, among other things, allowed stenotypic species (restricted tolerance to a narrow range of environmental conditions) to extend their range beyond their current limits, and eurytypic ones (broad tolerance to a wide range of environmental conditions) to thrive extensively across the country. The consequence of high mortality in a highly vulnerable to floods, which are manifest on different scales, revealing in particular a real ‘borderline effect’ between France and Germany.

What those studies also point out, however, is that the fight against floods has been at all times the manifestation of political will, mostly a reaction to disaster, and thus has been constantly re-defined in any context of important changes in the political structures. This is of course a lesson for the future.

1101-POSTER PRESENTATIONS

P-1101-02

Vulnerability of North Eastern region of India - a global biodiversity hotspot - due to anthropogenic threats and climate change book

S. Baruah (1) ; N. Hazarika (2) ; K. Mazumdar (3)

(1) Independent Consultant, Guwahati, Assam, India; (2) State Project Officer GOI-UNDP programme, Assam state disaster management authority, Guwahati, India; (3) Programme Officer GOI-UNDP programme, Assam state disaster management authority, Guwahati, India

Climate change poses major threats to all levels of biodiversity from genes to landscapes while local level changes within landscape affects its composition and abundance. The North Eastern region (here after referred as ‘NER’) India refers to the easternmost region of India consisting of eight sister states. The region is biogeographically and culturally distinct from rest of India and has strong ethnic and cultural ties with East Asia.
ABSTRACT BOOK

ABSTRACT BOOK to more increased extra-tropical specific humidity. As a total annual mean pliocene Mediterranean runoff is about analysis of forest cover statistics of ner of india for last geocological fragility, strategic location vis-à-vis the greatly affected by climate change as well as increasing atmospheric general circulation model, we simulate pleistocene transition, about 3 Ma. By means of a stand-Mediterranean runoff variability during the pliocene of global meridional and zonal sst gradients on the impact of global SST gradients on the P-1101-03

Impact of global SST gradients on the Mediterranean runoff changes across the Plio-Pleistocene transition

F. Colleoni (1); A. Cherchi, (1); S. Masina, (1); C. Brierley, (2)
(1) Centro Euro–Mediterraneo sui Cambiamenti Climatici, Bologna, Italy; (2) University College of London, Department of Geography, London, United Kingdom

This work explores the impact of the development of global meridional and zonal SST gradients on the Mediterranean runoff variability during the Plio-Pleistocene transition, about 3 Ma. By means of a stand-alone atmospheric circulation model circulating the separate impact of extra-tropical and equatorial SST cooling on the Mediterranean runoff. Results show that total annual mean Pliocene Mediterranean runoff is about 40% larger than during the pre-industrial period due to more increased extra-tropical specific humidity. As a consequence of a weakened and extended Hadley cell, Pliocene northern Africa hydrological network produces a discharge 30 times larger than today. Our results support the conclusion that during the Pliocene, the Mediterranean water deficit was more reduced than today due to a larger river discharge. While the cooling of equatorial SST does not imply significant changes on the Pliocene Mediterranean hydrological budget, the extra-tropical SST cooling increases the water deficit due to a decrease in precipitation and river runoff. This results in decreased river runoff to pre-industrial level. From our simulations there is evidence that the present atmospheric circulation over the Mediterranean started to develop at least 3 Ma. The main teleconnections in the Mediterranean region, i.e. the North Atlantic Oscillation during winter and the “monsoon-desert” mechanism during summer are already at work in our Pliocene simulations. Finally, our results are consistent with a region that experienced warmer than today, changes of the Hadley circulation could potentially lead to increased water resources in northwest Africa.

P-1101-04

Mid-Holocene drought impact on the active Lazaun rock glacier in the Italian Alps

JN. Haas (1) ; B. Dieter (1) ; M. Hirsnapser (2) ; D. Bressan (2) ; C. Walser (3) ; I. Hajdas (4) ; K. Lang (5) ; V. Mair (5) ; U. Nickus (6) ; D. Reidl (7) ; H. Thiers (7) ; D. Tonidandel (5) ; K. Kranner (2)
(1) University of Innsbruck, Botany, Innsbruck, Austria; (2) University of Innsbruck, Geology, Innsbruck, Austria; (3) University of Bamberg, Archaeology, Bamberg, Germany; (4) ETH Zuerich, Physics, Zuerich, Switzerland; (5) Office for Geology and Building materials testing, Autonomous Province of Bolzano, Italy, Bolzano, Italy; (6) University of Innsbruck, Meteorology, Innsbruck, Austria; (7) University of Innsbruck, Ecology, Innsbruck, Austria

The study of a 40 m-long ice and debris core from the rock glacier Lazaun in the southern Oetztal Alps (South Tyrol, Italy) revealed a mid-Holocene drought impact around 4000 cal. BP. Plant macrofossils embedded in the ice indicated the overall formation of the rock glacier around 10’300 cal. BP with two superimposed rock glacier lobes persisting active since then. The inferred age-depth model implied very stable sedimentation conditions for snow, ice and rock debris throughout the Holocene, with the exception of a mid-Holocene drought event. This multi-centennial drought period around 4000 cal. BP was probably related to increased snow accumulation, prevailing warm climate, and a general Mediterranean/Central European climatic reorganization. The palaeoecological study of the ice/debris samples and the quantification of pollen and n-pollen (non-pollen palynomorphs), charcoal particles as well as plant and animal macrofossils allowed tracing the former climatically and anthropogenically induced vegetation changes at alpine altitudes (above 2600 m a.s.l.).

P-1101-05

Orbital, solar, volcanic and anthropogenic forcings in the Holocene glacier fluctuations

O. Solomina (1) ; D. Hodgson (2) ; A. Nesje (3) ; L. Owon (4) ; H. Wanner (5) ; G. Wiles (6) ; N. Young (7) ; R. Bradley (8) ; S. Ivy-Ochs (9) ; V. Jomelli (10) ; A. Mackintosh (11)
(1) Institute of Geography, Moscow, Russia; (2) British Antarctic Survey, Cambridge, United Kingdom; (3) University of Bergen, Department of Geography, Bergen, Norway; (4) University of Cincinnati, Department of Geology, Cincinnati, United States of America; (5) Institute of Geography and Oeschger Centre for Climate Change Research, Bern, Switzerland; (6) The College of Wooster, Department of geology, Wooster, United States of America; (7) Columbia University, Lamont–doherty earth observatory, Palisades, United States of America; (8) University of Massachusetts, Department of Geography, Amherst, United States of America; (9) Institute of Particle Physics, Zurich, Switzerland; (10) CNRS, Physical geography, Meudon, France; (11) Victoria University Wellington, Antarctic research centre, Wellington, New Zealand

Glacier fluctuations integrate both temperature and precipitation, and these signals are often a challenge to separate. However, in the end of 20th–early 21st centuries
the glaciers demonstrate a coherent pattern of uniform retreat, despite the great difference in their morphology, sizes, location and other characteristics. For our global overview of Holocene glacier fluctuations we used 189 time series of glacier fluctuations based on 14C, TCN, OSL, tree rings, sediments from proglacial lakes, and speleothems. We compared the glacier variations with orbital, solar and volcanic forcings and considered the scale and the rate of modern glacier retreat in the context of Holocene natural variability. The general trends of Holocene glacier fluctuations in the extra–tropical areas of the Northern Hemisphere are broadly coherent and agree with the dynamics of the Northern and mountain tree lines. Overall summer temperature, forced by orbitally-controlled insolation, is the most probable driver of increasingly more expansive advances through the Holocene in these regions. In the Southern Hemisphere, glaciers in New Zealand and Argentina to total trends response to the Northern Hemisphere (less expansive advances through the Holocene). Glacier fluctuations in monsoonal Asia and in Southern South America generally do not correlate with the orbital climate records and instead respond to more high resolution forcings in these regions. Glacier advances during Neoglacial clustered at 4.4–4.2, 3.8–3.4, 3.3–2.8, 2.6, 2.3–2.1, 1.5–1.4, 1.2–1.0, 0.7–0.5 ka BP correspond to general coolings in the North Atlantic. Some of these episodes coincide with multidecadal periods of low solar activity, but it is unclear what mechanism might link small changes in irradiance to widespread glacier fluctuations. One cluster of glacier advances at 1.7–1.6 ka does not fit this pattern and probably corresponds to a very strong volcanic eruption (232 CE). Thus, no single driving mechanism explains all ice expansions. The rate and the global character of glacier retreat in the 20th–early 21st centuries appears to be unusual in the context of Holocene glacier changes, however retreating glaciers in most regions have become more pervasive in the Early and/or Mid–Holocene. Since contemporary retreat is occurring during an interval of orbital forcing that is favorable for glacier growth, a combination of factors other than orbital forcing, primarily strong anthropogenic influence, is likely in effect. Due to the delayed reaction of glaciers to climatic changes, retreat will continue into future decades. In some cases the large changes inferred from glacier records are more pronounced than reconstructions based on higher resolution records and models driven by solar forcing. This observation may indicate that other proxies on higher resolution records and models driven by solar and volcanic forcings are also likely in effect. Due to the delayed reaction of glaciers to climatic changes, a combination of factors other than orbital forcing, primarily strong anthropogenic influence, is likely in effect. However, despite the number of detailed reconstructions increasing during the last decades, a coherent history of the climatic changes has been hindered by uncertainties in the apparent timing and amplitude of these hydrological changes inferred from truncated outcrops point to regional climatic variability fluctuations as well as site-specific influences which could bias the evolution of water balance. Increasing the numbers of observations and reconstruction contribute to arise regional patterns, and render complex the identification of the climatic signal.

In this paleoclimatic history, one of the main attractive phase, still debated, is the end of the mid–Holocene humid period. The increasingly arid conditions after 5,000 years forced Neolithic societies to improve their organization in order to optimize natural resources, in particular freshwater supplies, and to explain the rise of civilizations that flourished along the main rivers such as Nile, Euphrate or Indus. This climatic change corresponds in time with the gradual modulation of the monsoon, whereas data from marine records evidenced the environmental changes could be more abrupt than expected by the sinuous insolation curve. But on the continent, the data tell us another history. Lake Yoja record collected in the northern Chad in Sahara desert shows that vegetation and dust fluctuations occurred gradually, in concert with the slowly weakening monsoon.

In this context, we present new records with original data depicting past increasing hydroclimate history since the LGM from the key, but yet poorly investigated, Lake Chad. In Northern Africa, Lake Chad appeared as one of the main emblematic site during this period of time. Reaching 10 times its surface area, it was one of the main water tower during this period. Almost exclusively fed by the Chari–Logone river system that originates from the wet tropics, where precipitation is directly controlled by the West African Monsoon and the seasonal migration of the ITCZ, this particular configuration makes this terminal lake a very sensitive indicator of climate and the environment evolution of north–central Africa at various time–scales. Then, here we present continuous records from past environmental and climatic changes during the last 20,000 years. We highlight coherent monsoonal changes, compared with the wet tropical seasonally drier basins, e.g. tropical Atlantic and Indian oceans, as well as at the scale of the continental tropical belt. Moreover, drastic hydrological changes are recorded, occurring in few centuries, matching with North Atlantic cold spells indicating that Northern African climate could switch from a state to another, quickly, which drive in consequence, ecosystem and human adaptations.

During the last 20,000 years, Northern Africa experienced dynamic climatic and subsequent environmental changes, characterized by a succession of contrasted period. It is now well established that the Last Glacial Maximum (LGM) was dryer followed by a wetter middle Holocene, punctuated by dry events. The numerous Holocene paleolake records document a fairly consistent pattern of a moister early–Holocene resulting in a “Green Sahara” followed by a general aridification ca. 5000 years ago, which still persist today.

**P-1101-06**

**Monsoonal changes recorded by Lake Chad sedimentary archives during the Neolithic**

F. Sylvestre (1) ; P. Amaral (1) ; P. Deschamps, (1) ; N. Waldmann, (2) ; K. Tachikawa, (1) ; D. Delanghe, (1) ; N. Thouveny, (1) ; E. Bard, (1) ; M. Garcia, (1) ; J.C. Mazur, (1) ; JC. Doumnang, (3) ; G. Menot, (1) ; F. Rostek, (1)

(1) Aix-Marseille University, CNRS,IRD, Collège de France, Marseille, France; (2) University of Haifa, Department of marine geosciences, Haifa, Israel; (3) University of N'Djamena, Department of geology, N'Djamena, Chad

**K-1102-01**

**Past climate event suggests severe and long-lasting consequences of fossil fuel burning**

RE. Zeebe (1)

(1) University of Hawaii at Manoa, Department of Oceanography, Hawaii, United States of America

Carbon release rates from anthropogenic sources have reached a record high of ~10 Pg C/y in 2014. Due to uncertainties in climate system feedbacks, the impact of the rapid carbon release on the Earth system is difficult to predict. Hence geologic analogues from past transient climate changes are urgently sought after to guide future climate assessments. Throughout the past 65 million years, the well known climatic aberration with the highest carbon release rate is the Paleocene–Eocene Thermal Maximum (PETM) – an event characterized by future–relevant total carbon release/peaking warming and a carbon flux direction of at least 40 Pg C/yr per 10,000 years. Based on time–series analysis of stable carbon/oxygen isotope records and carbon cycle/climate modeling, we determine the initial carbon release during the PETM onset. This constrains the magnitude of the orbital trend, which is on the order of ~10 Pg C/y. Given currently available records, it follows that the present anthropogenic carbon release rate is unprecedented during the past 66 Myr by at least an order of magnitude. Future climate evolution and responses could hence exceed the relatively limited extinctions observed at the PETM. Moreover, unforeseeable future responses of the climate system are possible as the Earth system has effectively entered an era of no-analogue state.
K-1102-02
Understanding a warming world by studying the Pliocene
A. Haywood (1)
(1) University of Leeds, UK national centre for atmospheric science, Leeds, United Kingdom

The investigation of warm intervals of the Pliocene epoch has intensified dramatically over the last 10 years. The reasons for this are varied but undoubtedly the availability of progressively higher temporal and spatial resolution environmental records is a key driver. These reconstructions are providing new insights into environmental change during the Pliocene, which enable us to look into the constraints climate change under an atmospheric CO2 concentration akin to the modern. Furthermore, the use of Climate and Earth System Models in a Pliocene context has been encouraged as a means to test the performance of models, and to understand climate processes generating regional patterns of environmental change.

This presentation will summarise the current state of knowledge of the Pliocene Earth System derived from proxy data and model outputs. In particular it will focus on key aspects of the climate system such as the reconstruction of atmospheric CO2 sheet and sea-level change, surface temperature change and polar amplification, the hydrological cycle, ocean circulation and the monsoons.

Challenges in environmental reconstruction and modelling will be highlighted with a summary of emerging initiatives, which are designed to enhance our ability to use warm intervals of the Pliocene as a mechanism to understand the dynamics and drivers of a warming world.

K-1102-03
Climate change and variability: lessons from the past
P. Braconnot (1)
(1) LSCE–IPSL, Gif-sur-Yvette, France

Past climate states provide a unique opportunity to evaluate model performance outside the range of recent observed climate variability. They provide test cases of our understanding of climate feedbacks and thresholds that are not observed in modern variability and that could lead to major changes in the future. Because of the past climate simulations of the Last Glacial Maximum (21 000 years BP), the mid-Holocene (6000 years BP) and the last 1000 years, they have been considered as part of the last multi-model CMIP5/PMIP3 experiments (Taylor et al. 2012, Braconnot et al. 2012), so as to put in perspective future climate changes and provide complementary model evaluation. Unlike the simulations and model comparisons, this presentation will provide an overview of recent analyses of climate sensitivity and feedbacks, a hydrological cycle in the tropical regions, and intrannual climate variability. It will highlight the new possibilities offered by the modeling of the biological cycles and tracers or by the high resolution records that provide information on interannual to multi-decadal variability. Finally, it will discuss the constraints these analyses bring on the credibility of model as well as the new questions that will be addressed in the next phase of the Paleoclimate Modeling Intercomparison Project (PMIP).

O-1102-02
Long-term evolution of feedbacks in a GCM run to equilibrium
A. Hannart (1); JL. Dufresne, (2); C. Li, (3); R. Knutti (4)
(1) CNRS, IFAÉC, Buenos Aires, Argentina; (2) CNRS, LMD, Paris, France; (3) Max Planck Institute for Meteorology, the Ocean in the Earth System, Hamburg, Germany; (4) ETH, Zurich, Switzerland

Equilibrium climate sensitivity (ECS) is a common measure of Earth’s global temperature response to radiative forcing. To first order, Earth’s radiative imbalance decreases linearly with global temperature anomaly when a step forcing is applied. ECS is thereby assumed to be constant and inversely related to the linear feedback coefficient (λ). The validity of this linear approximation has been increasingly questioned recently, showing that feedback are state- and time-dependent. But can these deviations from linearity significantly shift the final equilibrium state actually reached by a GCM as compared to the linear extrapolation based on the last centuries given by ECS, or even imply a bifurcation leading to a vastly different equilibrium? What are the dominant physical processes that explain them? Here we analyze the evolution of feedbacks in the six thousand years-long integration to equilibrium of the coupled climate model ECHAM5/MPIOM under atmospheric CO2 quadrupling – the only simulation to equilibrium of a state-of-the-art GCM available to date. In our historical and paleoclimate studies, the global feedback λ changes significantly over the entire integration, but more surprisingly its evolution is markedly non-monotonic. Indeed, while a λ decrease is expected to occur during the first thousand years of the run – which is the period partly analyzed by most previous studies and hence yields consistent findings, we observe a steep increase in λ(0.4 up to 1.8 Wm-2K-1) throughout the remaining five thousand years, until the equilibrium is reached. This evolution is predominantly driven by: (i) a...
and steeper increase in cloud feedback over the entire simulation period is mainly associated to increasing aerosol levels, and direct and indirect radiative forcing. A combination of climate sensitivity to the aerosol levels, and the interactions between aerosol feedback and surface temperature. The combined aerosol greenhouse forcing has important regional and global consequences, and have to be corroborated by other models but also by detailed studies to identify the key processes and evaluation of the models towards observations. However, our results strongly imply that a continued strong temperature increase will prevail for many years forward.

REFERENCES

O-1102-04
Deep past carbon cycle and climate crises
G. Ramstein (1); Y. Donnadieu (1); Y. Godderis (2)
(1) LSCE, Gif-sur-Yvette, France; (2) CNRS, Geosciences environnement toulouse, Toulouse, France

Deep past carbon cycle and climate crises

Relationships between carbon cycle and climate are intensively studied for ongoing global warming. There are also in the geological past of the Earth, key periods when huge changes of atmospheric carbon led to drastic cooling: Snowball episodes at Neoproterozoic [800–600 Ma]. Another period of interest is the so-called “terrestrialization” of the Earth, which also led to a decrease of atmospheric carbon but without producing an important cooling during Late Devonian [379–359 Ma]. For the first time period, we will show how terrestrial–climate feedbacks and greenhouse gas concentrations can enable a transition to a very different climate. This to bring about a change in the sign of atmospheric CO2 associated with vegetation development. However, we need to better understand how these deregulations developed and which processes associated with atmospheric carbon–tektontics – biosphere and water cycle may explain the onset and the decay of such crises.

O-1102-05
Causes and consequences of mid-Holocene aridity in mid-continental Eurasia in the CMIP5 simulations
S. Harrison (1); K. Izumi, (2); G. Li, (3); P. Bartlein, (4)
(1) University of Reading, Reading, United Kingdom; (2) Laboratoire de Météorologie Dynamique, IPSL, CNRS, Paris, France; (3) Macquarie University, Department of biological sciences, North Ryde, Australia; (4) University of oregon, Department of geography, Eugene, United States of America

The extent of mid–continental drying in Eurasia during the mid-Holocene is an example of a persistent regional mismatch between models and observations. The CMIP5 mid-Holocene simulations show drier conditions in Europe than observed during the Holocene. Additionally, the extent of palaeoenvironmental data systematically show that the region was wetter than today. At the same time, the models show significantly higher summer temperatures, whereas observations indicate that summers were cooler. The simulated temperature bias can be up to 4–6 °C. Temperature biases in the CMIP5 historical (20th century) simulations are linked to systematic biases in evapotranspiration. Diagnosis of the surface energy balance in the mid-Holocene CMIP5 experiments shows that the simulated increase in summer temperatures results from the simulation of too–low evaporative cooling because of water limitation. Surface water–evaporation balance interactions play a similar role in mediating the temperature response in CMIP5 future simulations.
**O-1102-06**

Climate Change in the Past 2000 Years and its impact on society on the Tibetan Plateau

T. Yao (1); X. Yang (1); P. Yao (1); N. Wang (2); L. Tian (1); B. Xu (1); H. Zhao (1); J. Gao (1); DR. Joswiak (1)

(1) Chinese Academy of Sciences, Institute of Tibetan plateau research, Beijing, China; (2) Chinese Academy of Sciences, Cold and Dry regions environmental and engineering research institute, Beijing, China

Temperature variation on the Tibetan Plateau (TP) in the past 2000 years is reconstructed using stable oxygen isotope in five ice core records on the TP, including Dunde ice core in northeast TP, Guiyu ice core in northwest TP, Dasuopu ice core in south TP and the Puroogangri and Tanggula ice core in central TP. The integration of the ice core records reveals the synchronicity of long-scale changes in Tibet, such as the warming in the 7th century, 12-13th centuries and the present, and the cooling in the 3rd century, 16th century, and 19th century. We referred to human historical documentary record since A.D. 620 for possible responses of social, economic and military activities to climate changes. By focusing especially on human activities, and social development directly determined or indirectly influenced by climate from historical documentary record, we quantified those events into five aspects i.e., economy, resources, economic development, military strength, national coherence, and cultural and religious development, to study social development on the TP by A.D. 1900. Our results show a close Tibetan society response to climate changes in the past 2000 years, particularly before the modern ages.

**O-1102-07**

AMOC Evolution in the Last Deglaciation: Forcing Mechanism, Thermo-haline Instability and Implications

Z. Liu (1)

(1) University of Wisconsin-Madison, Atospheric and Oceanic Sciences, Madison, United States of America

The forcing mechanism and instability of the Atlantic Meridional Overturning Circulation (AMOC) over the last 21,000 years is studied using transient simulations under realistic forcings in the NCAR CCSM3. First, in addition to the strong millennial AMOC variability forced by melting sea ice feedbacks in the North Atlantic. As a result, the AMOC strength does not change significantly after the deglaciation. Second, the model AMOC exhibits a monostable behavior. The monostable AMOC, which has been observed in almost all state-of-art coupled general climate models (CCGMs), is likely to be caused by a systematic model bias that is associated with the prescribed freshwater flux and AMOC freshwater export. This AMOC over-stabilization bias needs to be improved in these CCGMs to allow for a credible projection of AMOC evolution in the future.

**O-1102-08**

Different vegetation responses to climatic droughts in the Mediterranean basin

C. Gouveia (1); R. Trigo (1); S. Beguería, (2); SM. Vicente-Serrano (3)

(1) Instituto Dom Luiz (IDL), Faculdade de Ciências da Universidade de Lisboa, Lisboa, Portugal; (2) Estación Experimental de Aula Dei, Cisca, Zaragoza, Spain; (3) Instituto Pirenaico de Ecología, Zaragoza, Spain

A number of recent studies have identified a significant increase in the frequency of drought events in the Mediterranean basin. Climatic droughts are relatively frequent in the Mediterranean region as a consequence of the large interannual variability of precipitation, and long periods with low precipitation. Several studies characterized climatic droughts in the Mediterranean region, emphasizing the spatial and temporal complexity of this phenomenon.

The use of remote sensing data holds a great potential since it allows analyzing a consistent dataset with high spatial and temporal resolution. Several studies analyzed the impact of droughts on the natural vegetation and crops using remote sensing data. The majority of the studies focused on drought impact with the confidence of severe drought episodes. The vegetation cover considered droughts as a precipitation shortage regarding the normal climatology. Nevertheless, recent drought episodes in the frame of a warming scenario have shown that large evapotranspiration rates associated to high temperatures are equally relevant and may trigger severe droughts. Therefore, in the present scenario of temperature rise it is necessary to acknowledge the impacts of both reduction in precipitation and increase in evapotranspiration rates.

The aim of the present work is to analyze in detail the impacts of drought episodes on vegetation in the Mediterranean basin behavior using NDVI data from (GiMMS) for entire Mediterranean basin (1982–2006) and the multi-scale drought index (the Standardised Precipitation–Evapotranspiration Index (SPEI)).

Correlation maps between fields of monthly NDVI and SPEI for at different time scales (1–24 months) were computed in order to identify the regions and seasons most affected by droughts. Affected vegetation presents high spatial and seasonal variability, with a maximum in summer and a minimum in February. Observed large leads are caused by a systematic model bias that is associated to the tropical bias, the resulted freshwater flux and be controlled by retreating ice. Furthermore, this conclusion is reinforced by the strong control of drought on vegetation dynamics is obtained during February and May. Drought events over areas with low water balance values. Accordingly the wet and cold seasons present low water balance values that implies shorter time scales over dry cluster, whereas high water balance implies longer time scales over Central and Atlantic clusters.

The occurrence of most affected areas over regions presenting low water balance values highlights the strong dependence of vegetation with climate variability. Furthermore, this conclusion is reinforced by the strong control of drought on vegetation activity observed for Arid and Steppe clusters located over areas with higher absolute values of water balance. The projected increase in frequency of drought episodes emphasize the need for an early warning drought system covering the entire Mediterranean basin. However, our results highlight that this requirement is dependent of vegetation types, season of the year and relative location of the regional sector considered. We are confident that our results will provide a useful tool for drought management plans and will play a relevant role in adaptation to the impact of such episodes within the context of climate change.

**O-1102-09**

Observed large holds of Atlantic circulation slowdowns with respect to tropical precipitation events: A challenge for current climate models

C. Waelbroeck (1); P. Burckel, (1); S. Pichat, (2); J. Gherardi (3); H. Arz, (4); J. Lippold, (5); T. Dokken, (6); F. Thil, (1)

(1) LSCE/IPSL, CNRS, Gif-sur-Yvette, France; (2) LCL–TPE, École normale supérieure, Pari, France; (3) DAEI, Issy les Moulineaux Cedex, France; (4) Leibniz Institute for Baltic Sea Research, Rostock, Germany; (5) Oescher Centre Climate Change Research, University of Bern, Bern, Switzerland; (6) BCCR, University of Bergen, Bergen, Norway

The cores MD09–1257 and GeoB1910 were retrieved off northern Brazil at ~4°S, 36°W and 2340 m water depth. Their chronology is derived from a corrected and calibrated radiocarbon–based age–depth model. As in other marine cores from this area, XRF measurements show marked Ti/Ca and Fe/Ca peaks over the last glacial that have been interpreted to reflect increased terrigenous input due to increased precipitation and runoff from the adjacent continent. These terrigenous peaks can be shown to be covariant with precipitation events recorded in tree rings at d18O records from South America in the 0–30°S latitudinal band, which are considered to reflect southward shifts of the intertropical convergence zone during Greenland stadials.
ABSTRACT BOOK

New sedimentary 231Pa/230Th measurements from core MDD9-3257 show that large changes took place in the overlying water mass flow rate over the last glacial in conjunction with millennial precipitation events. Furthermore, our C. wuellerstorfi δ13C data indicate that water ventilation was reduced at ~2340 m in the tropical Atlantic during Greenland stadials, in phase with the reduction in water mass flow revealed by Pa/Th data. Our results thus demonstrate that major slowdowns of the Atlantic Meridional Overturning Circulation (AMOC) upper circulation cell took place during Greenland stadials.

Because both rainfall events and changes in ocean circulation are recorded in the same sediment core, we were able to reliably determine that the AMOC started to slowdown 1420 ± 250 and 690 ± 180 (1σ) y before the onset of two large South American precipitation events associated with Heinrich stadials.

Our data open new prospects concerning causal mechanisms of rapid climate changes. More specifically, current climate models simulate a rapid response of the tropical climate to AMOC changes, whereas our results indicate that there is a large lead of AMOC changes with respect to tropical climate changes. Therefore, more work, both data- and model-wise, is necessary in order to achieve a better understanding of the highly nonlinear behavior of the climate system observed in climate archives and to extend the scope of comprehensive climate models used for climate projections capture the full extent of ocean–ice sheets–atmosphere interactions.

1102—POSTER PRESENTATIONS

P-1102-01
Impact of Climate Change on Onset, Amount and Length of Rainy Season over West Africa as Simulated by COORDEX Models

E. Adefisan (1)
(1) Federal University of Technology, Akure, Department of Meteorology and Climate Science, Akure, Ondo State, Nigeria, Federal Republic of

The onset of rainfall signals the commencement of viable agricultural activities and it is therefore very essential for planning farm operations in West Africa. Impact of climate change on the rainfall onset dates (RODs), rainfall cessation dates (RCDs) and hence the length of the rainy season (LRS) as the rainfall amount during the season over West Africa is therefore a welcome idea. The data used was from the Coordinated Regional Downscaling Exercise (COORDEX-Africa) and comprises of daily rainfall for four of the participating regional climate models of scenario A1b of the Intergovernmental Panel on Climate Change (IPCC). The simulated data was divided into two with 1981–2000 serving as present and 2031–2050 representing the near future. RODs was found to be delayed by two weeks (14 days) over most part of West Africa and a delay of three weeks (21 days) over most part of Sierra Leone, Liberia, Guinea, western flank of Cote d’Ivoire and some parts of Mali. RCDs were seen to be earlier in the near future than present in most part of West Africa. ROD which is the difference between the RODs and RCDs show that there is a reduction of between 15 and 25 days in the areas mentioned early in the season over West Africa. Apart from these, most West African sub-region experiences reduction in the annual rainfall amount ranging from 120mm to about 300mm. On a closer look at rainfall amount from June to September (JJAS) rainfall amount, it follows the same trend as that of the annual amount but with more significant reduction in the near future. From coast to about 60N, there is an average reduction of between 0.2 to 0.6mm/day (24 to 73mm). From about 60N to 140N there is an increase in rainfall amount of about 0.7mm/day. There is a significant reduction of JJAS rainfall amount on the leeward side of Cameroon’s Mountain of 1.4mm/day.

P-1102-02
Climate Variability in Nepal: A Time Series Approach

RB. Bista (1)
(1) Patan Multiple Campus, Tribhuvan University, Economics, Lalitpur, Nepal

Climate variability in Nepal has become a big environmental issue. This paper investigates empirically and analytically whether climate variability exists or not in different altitudes, whether its direction moves and what will be its future direction. We use time series model based on the secondary data of hydrology and metrology collected from Department of Hydrology and Metrology, the Government of Nepal.

The time series analysis finds climate variability in the different parts of Nepal in which all months have variability of temperature and rainfall respectively. Therefore, more work, both data- and model-wise, is necessary in order to achieve a better understanding of the highly nonlinear behavior of the climate system observed in climate archives and to extend the scope of comprehensive climate models used for climate projections capture the full extent of ocean–ice sheets–atmosphere interactions.

P-1102-03
How will climate change affect the vegetation cycle over France? A generic modeling approach

D. Carrer (1) ; N. Laanaia (1) ; JC. Calvet (1)
(1) Meteo France, CNRM–GAME, Toulouse, France

The expected response of climate to the increase in greenhouse gas concentration during the 21st century is a 2–3°C warming in Europe (IPCC 2007). However, the sign of the response differs from a climate model to another. Two climate models predicting the same sign in the response of temperature and precipitation, but presenting different magnitudes of change, can lead to very different impacts. This paper investigates empirically and analytically whether climate variability exists or not in different altitudes, whether its direction moves and what will be its future direction. We use time series model based on the secondary data of hydrology and metrology collected from Department of Hydrology and Metrology, the Government of Nepal.

In the framework of the ORACLE ANR project, CNRM has produced 150–yr (1950–2100) simulations over France of the biomass of various vegetation types (straw cereals, grasslands, broadleaf and coniferous forests) and of the soil water content associated to each of these vegetation types. The ISBA–A–gs generic LSM, able to work at various spatial scales (local to global), was used. Thirteen climate simulations from the future IPCC assessment report, disaggregated at a spatial resolution of 8 km by 8 km, were used to drive the ISBA–A–gs model, over 191 grids cells representing the main French agricultural and forest regions. Statistical methods were used to quantify the impact of climate change and the agreement between climate models between near future (NF) (2020–2049), far future (FF) (2070–2099) and a reference past period (1970–1999). Everywhere in France, the duration of dry (wet) periods within one year increases (decreases), up (down) to (+) 30d in NF conditions. For all the vegetation types, leaf onset and the annual maximum LAI occur earlier. On the other hand, large regional discrepancies are simulated for the senescence period (e.g. earlier in western and southern France for broadleaf forests, later in eastern France) for both NF and FF. The length of the growing period is often more uncertain in FF than in NF in relation to differences in climate models. These simulations will be extended to the Euro–Mediterranean area and coupled with a hydrologic model. The new IPCC simulations will be used to complete this work.

ACRONYMS:
- ORACLE : Opportunités et Risques pour les Agro-écosystèmes et les forêts en réponse aux changements CLimatiques, socio-économiques et politiques en France
- ISBA–A–gs : Interactions Soil–Biosphere–Atmosphere model, including photosynthesis and vegetation growth
- LAI : Leaf Area Index
P-1102-04

Identifying future climate change hotspots over Southeast Asia

F. Cruz (1); J. Dado (2); K. Cheng Chua (1); E. Gozo (1); G. Narisma (1)
(1) Manila Observatory, Quezon City, Philippines; (2) Tokyo Metropolitan University, Department of geography, Hachioji, Japan

Southeast Asia is one of the regions most vulnerable to the impacts of a changing climate in a globally warmer future. In this study, climate variables from multiple CMIP5 global climate model output have been analyzed to describe the spatial extent and magnitude of future changes over the region. Potential climate change hotspots, i.e., areas indicating strong response to changes in climate, can therefore be identified. This is important for adaptation planning in the different sectors, including agriculture, on which the de-bonding of climate metrics is highly dependent. Initial results show that in the 2030s under the Representative Concentration Pathway (RCP) 4.5 scenario, high changes in the mean climate are likely to occur over Indochina, a region described by high seasonality in rainfall. On the other hand, significant changes in the extremes are noted over the Maritime Continent. However, changes in the location and intensity of these hotspots may still occur depending on the time period and emissions scenario.

P-1102-05

Recent sea-surface pH and SST changes in the eastern equatorial Pacific (Clipperton Reef) inferred from coral geochemistry

D. Dissard (1); D. E. (2); T. Correge (3); M. Mcculloch (4)
(1) IRD, Paris, France; (2) LSCE, Gif-sur-Yvette, France; (3) EPOC, Bordeaux, France; (4) UWA ARC, Perth, Australia

Increased atmospheric CO2 concentrations from 280 (pre-industrial value) to 390 ppmv (present value) have decreased global surface ocean pH by approximately 0.1 units in the last century, with atmospheric pH suggesting a further decrease of 0.3 pH units by the end of the century. Geochemical records preserved in the carbonate skeleton of shallow water coral presentations provide one of the few means to reconstruct changes in seawater carbonate chemistry. However, since the early 1990s, when the potential of δ11B in biogenic carbonate as proxy for paleo-pH was realised, only few studies report on the recent dissolution of corals in the eastern equatorial Pacific, which is an appropriate timescale for studying the effects of ocean acidification driven by anthropogenic emissions of CO2.

The French island of Clipperton is the easternmost coral atoll in the Pacific Ocean located approximately 1200 km off the coast of Mexico. Due to the small number of ecological niches suitable for coral reefs development, and the poor hydrographic conditions, coral reefs exist on the eastern Pacific. The possibility to work on coral presentations from Clipperton’s therefore represents a unique opportunity to obtain information on surface seawater properties (e.g., T°C, carbonate chemistry) of this key area of the central eastern Pacific Ocean. As part of this study we have undertaken, boron and oxygen isotope compositions and elemental ratios (Sr/Ca, Mg/Ca, B/Ca, Li/Ca) have been determined over the last 80 years of a coral core retrieved in a colony of Porites australiensis located 10°17.506N/109°13.508W, Clipperton island, 10m depth. Boron isotopes were measured by MC–ICPMS, while elemental concentrations were determined using ICP-QMS. Isotopic compositions and elemental concentrations were used to quantify changes in seawater environmental parameters and their significance on the global or more regional Pacific oceanic circulation will be discussed.

P-1102-06

The Past is an Essential Element of the Future

E. Griffin (1)
(1) National Research Council Canada, Dominion Astrophysical Observatory, Victoria, BC, Canada

In the natural world, changes happen almost constantly, sometimes rapidly, often very gradually. Those gradual changes demonstrate two important aspects of our living world and its climate: (1) how systems are evolving by natural processes and internal stimuli, and (2) how modulations are being forced on them through external stimuli such as altered conditions of their supplies, or imposed anthropogenic interference. Evolutionary changes have their own characteristic timescales and are controlled, but forced changes can be accelerated beyond their pace. Measuring that second type is the subject of this paper.

To understand the nature and rate of changes that are imposed by external stimuli, research MUST access observations and records throughout all the time-spans that are modelled. Modern modelling needs data in electronic formats, but since electronic (“born digital”) recording and archiving only commenced about 30 years ago, the output from those models can only be reliable over that time-span. Unfortunately, the anthropogenic interference that may have caused the changes we now seek to measure was already happening 30 years ago, so to obtain a more reliable base–line we must dig out much earlier data. Therein lies the challenge, because pre-digital data were recorded on paper, film, photographic plates or books, or (a bit more recently) on magnetic tapes that used primitive formatting without meta-data. Transforming any of those historical observations into modern electronic formats is an extra procedure that may require expert assistance and equipment as well as extra funding, with the result that a great many pre-digital data are still in theirvirgin analogue states and are thus inaccessible to modern research. They are constantly at risk of physical degradation and damage, and – worse still – of being dismissed as “unwanted” and thrown away.

The CODATA Task Group “Data At Risk” (DAR-TG) is investigating the plight of historical scientific data, and is actively raising awareness of them in order to help secure for science the information that they alone provide. The matter is growing increasingly urgent, although that information is totally unique to the relevant scientific domains on account of the long time-spans which are represented, and once the data have been recovered and researched (and there have been some very notable and ingenious efforts, as this paper will describe), the results can be fascinating, even startling.

This conference is an ideal opportunity to reflect on the dangers of NOT including sufficiently historical data when trying to model climate change. Without them, hopes of modelling and predicting two conditians in the future will without doubt be seriously compromised.

P-1102-07

Geochemical evidence of past atmospheric circulation along a 40-50°N longitudinal transect across Europe during the last climatic cycle

C. Hatté (1); C. Gauthier (2); D. Rousseau (3); P. Antoine (4); M. Fuchs (5); F. Lagroix (6); O. Moine (4); A. Sima (7)
(1) CEA, Laboratoire des sciences du climat et de l’environnement, Gif-sur-Yvette, France; (2) IRSN, Laboratoire des sciences du climat et de l’environnement, Gif-sur-Yvette, France; (3) CNRS, Institut National des Sciences de l’Univers, Paris, France; (4) CNRS, Laboratoire de géographie physique et de climatologie des régions tropicales et actuels, Meudon, France; (5) University of Giessen, Department of geography, Giessen, Germany; (6) CNRS, Institut de physique du globe de paris, Paris, France; (7) CNRS, Laboratoire de météorologie dynamique, Paris, France

Highlighting the impact on regional scale of global climate changes is a major issue in climatology and paleoclimatology. While large scale (global or continental) scale studies help evaluating the direct physical forcing of climate on ecosystems, constraining the effect of this forcing at local to regional scales is essential to evaluate ecosystem feedbacks on climate.

In paleoclimatology, isotopic organic geochemistry (d13Corg) of typical loess is now widely used to investigate past precipitation (average annual values and monthly distribution) and thus to tackle the impact of past climate changes on a regional scale. This type of study has been applied to several loess–palaeosol sequences along a 40–50°N transect from Western France to central Ukraine.
The d13Corg analyses were performed in parallel with those of other climate proxies, such as grain size, pedology, paleomagnetism and malacology. The investigated records cover the last climate cycle with sedimentation rates as high as 0.15 and 1 mm/yr during periods of loess deposition.

All these records show alternating periods of more or less pronounced climatic pejoration (glacial stadial) and improvement (interstadial). For the combined stadial cycle, all sequences for each climatic episode allow us to propose a schema of intensity of past climate change effects on the European continent. Here we highlight two precipitation gradients that prevailed during most of the last glacial period: a West-to-East decreasing gradient in mean annual precipitation and a North-to-South reinforcement of the seasonality.

P-1102-08

On increasing global temperatures: 77 years after Callendar

E. Hawkins (1); P. Jones, (2)
(1) University of Reading, Dept. of meteorology, Reading, United Kingdom; (2) University of East Anglia, Norwich, United Kingdom

In 1938, Guy Stewart Callendar was the first person to demonstrate that the Earth’s land surface was warming. Callendar also suggested that the production of carbon dioxide by the combustion of fossil fuels was responsible for much of this warming and change in climate. It is now 77 years since Callendar’s landmark study and we demonstrate that his global land temperature estimates agree remarkably well with more recent analyses.

P-1102-09

Climate change signals in Kenyan Rift valley lakes

E. Koech (1); L. Ogallo (2)
(1) University of Nairobi, Meteorology, nairobi, Kenya; (2) University of Nairobi and IGAD Climate Prediction and Applications Centre (ICPAC), Nairobi, Kenya

Climate over Kenya is largely arid and semi-arid, making drought the most common hazard. Floods and many other local hazards occur with most of them being location specific. These climate extremes often have far-reaching impacts on various life-supporting and economic sectors, including agriculture, tourism, food security, health, livestock, water resources, settlement, infrastructure, and environmental resources, among others. Climate change leads to increases in the frequency of droughts and other climate extremes with devastating impacts on livelihoods in many developing countries including Kenya. Thus, no country can have sustainable livelihoods and development without an effective disaster risk reduction and climate change adaptation policies. Such policies require good knowledge of the past, present and future climate at specific locations that are often missing in many developing countries.

This paper presents the space–time patterns of climate extremes in the Rift Valley parts of Kenya in order to delineate the evidence of changing climate. This is proxied by grain size, pedology, paleomagnetism and malacology. The investigated records cover the last climate cycle with sedimentation rates as high as 0.15 and 1 mm/yr during periods of loess deposition.

All these records show alternating periods of more or less pronounced climatic pejoration (glacial stadial) and improvement (interstadial). For the combined stadial cycle, all sequences for each climatic episode allow us to propose a schema of intensity of past climate change effects on the European continent. Here we highlight two precipitation gradients that prevailed during most of the last glacial period: a West-to-East decreasing gradient in mean annual precipitation and a North-to-South reinforcement of the seasonality.

P-1102-10

Assessing the potential impacts of climate change and reforestation on rainfall onset and cessation over West Africa

M. Mounkaila Saley (1)
(1) West African Climate Service Center for Climate Change and Adapted land Use (WASCAL), Meteorology, Ondo State, Akure, Nigeria, Federal Republic of

This study investigates the potential impacts of climate change and reforestation on rainfall onset and cessation over West Africa. It uses two observations (GPCP and TRMM) and two RCMs RegCM and WRF forced respectively with HadGEM and ECHAM for the present–day climate (1971–2004) and projected future climate (2031–2064) under rcp45 conditions. Four definitions (DEF1, DEF2, DEF3 and DEF4) of rainfall onset dates (ROD) and one of rainfall cessation dates (RCD) based on rainfall threshold are used in the present study. Observed and modelled observations appear to be closely connected to atmospheric CO2 changes during the last deglaciation.
climate change due to elevated greenhouse gas (GHGs) show that the temperature would likely increase over West Africa in both RCMs and also in the GCMs (HadGEM and ECHAM) more consistently over the Sahel. On the other hand, elevated GHGs would lead to a decrease in rainfall and temperature over the RCMs and GCMs although the decrease is much more consistent again over the Sahel. As for the future ROD, increase in GHGs indicates that regardless of the definitions used, northern Nigeria would have delayed ROD. The statistical structure of the monsoon dynamics in the areas where the highest impacts of climate change (i.e., latest ROD) are observed for each definition shows that the elevated GHGs in the future under rcp45 condition would lead to a shallower monsoon flow over the Sahel. However, there was no agreement between the RCMs (RegCM and WRF) on the potential impact of climate change on the RCDs due to elevated GHGs, for which RegCM indicates delayed RCDs over the Sahel and early RCDs over the Savanna, WRF produces early RCDs in all the areas. From both models, the projected impact of reforestation under the rcp45 condition indicates that West African climate would be cooler in most areas with more rainfall during the rainy season especially over the reforested zone. The cooling effect is more consistent and higher over Saharan reforestation would induce early ROD over most areas in West Africa as obtained from both models, except over north of Nigeria. The heterogeneity of the impact of reforestation on the RCDs (under rcp45 conditions) again produces divergent results by the RCMs. While RegCM indicates delayed RCDs over the reforested area and early RCDs over Saharan, WRF produces delayed RCDs over all the climatic zones.

P.1102-12
Spatial and temporal variability in observed and future projected precipitation in Bia basin (Ivory coast-Ghana)
M. N'diaye Hermann (1) ; KK. Lazare (1) ; YN. Alexis (2) ; KY. Morton (2) ; S. Issiaka (2)
(1) Centre de Recherche en Ecologie, Laboratoire géologie marine, sédimentologie et environnement, Abidjan, Ivory Coast and (2) Institute of Geosciences et environnement, Abidjan, Ivory Coast

The phenomenon of drought area desiccation that affected many African countries south of the Sahara have not spared the Ivory Coast, especially from the 1980s. The impact of these events resulted in significant climatic disturbances including abnormal extension of the dry season, the frequency and poor distribution of rainfall and significant reductions in agricultural yields in the southeast zone. The question is to know that these same phenomena will repeat in the future in the medium term (2030-2050) or long-term future (2070 and beyond).

Attempts to assess the changes between the observed (or historical) and future projected monthly rainfall for six stations throughout Bia basin have been made with descriptive statistics and value analysis. We obtained the monthly rainfall data from Coupled Model Intercomparison Project Phase 5 (CMIP 5) database. These data is downscaled using the change factor approach for 30 1981 to 2010 (period 0), simulation from 2021 to 2050 (period 1) and from 2070 to 2099 (period 2). The historical average rainfall data were obtained from RCP2.5, RCP 4.5, RCP 6 and RCP 8.5 scenarios, which are based on a model HadGEM2-ES and model IPSL-CM5A-MR. The first order Markov chain model was used to describe the occurrence of frequent wet and dry years. For the comparison of values, the return period estimates are obtained. To examine temporal changes in drought, a cluster analysis was conducted by Self Organizing Map (SOM) for Matlab. The minimum distance and the hierarchical clustering analysis method were performed using the value of the monthly. The number of optimum cluster was determined when the similarity between merged clusters decreased substantially. For the number of clusters and the number of ES and IPSL-CM5A-MR represents the precipitation annual cycles quite well in Bia basin with the respective average correlation coefficients of 0.78 and 0.80. From the descriptive statistics, we can observe that the number of heavy rainfall events will increase in the future. The total precipitation is projected to remain unchanged or slightly increased, compared to the observation. From the annually value analysis, we can observe that the return periods for dry episodes are almost constant, ranging from 1.20 to 1.45 years. In accordance with this we should conclude that no significant differences could be established among the different stations of the basin.

The short return period (1.05 years), reflecting the state of having a new dry episode, is observed in the Bia region during the period 2071 to 2099.

Subsequently, the monthly values with similar trends were grouped into two different clusters where the region G1 corresponds to northern Nigeria, and G2 the Southern region. The map shows that future droughts are projected to frequently occur in all regions, especially from the ~2021s to the early 2050s. The droughts in the Bia basin between the early 1970s and 1980s, seem to be distinguished in the same period. These were previously confirmed to be quite intense over annual timescales. For the period 2032-2035, intense droughts are expected to occur nationwide, which may also be observed in the Sahel, where sporadic drought is expected to occur in some regions, with more intense ones from the 2070s in the region G1 and G2. Lastly, in the year 2099, a short, intensive drought is expected to occur in all regions.

P.1102-13
Response of North Atlantic storm track to climate change in the CNRM-CM5 simulations
T. Oudar (1) ; E. Sanchez-Gomez (1) ; F. Chaunin (2) ; L. Terray (1)
(1) CERFACS/CNRS, Sciences de l’Univers au CERFACS, URA1875, Toulouse, France; (2) Météo-France, CNRM-GAME, Toulouse, France

Climate variability in Europe is largely controlled by North Atlantic storm tracks. They are associated with transport of energy, momentum, and water vapour, between the equator and the pole. Extratropical cyclones have caused severe damages over some regions in north-western Europe, since they can combine extreme precipitation and strong winds. The reason why the systems recur is not well understood. The impact of climate change on the extratropical cyclones, principally on their intensity, position or lifespan. Indeed, several recent studies have focused on this subject by using atmospheric reanalysis and general circulation models (GCMs). The main conclusions obtained from the CMIP3 simulations showed a decreasing of the total number of cyclones and a poleward shift of their tracks in response to global warming. In the recent CMIP5 exercise, the consensus is not so clear, probably due to more complex retroactions acting in the different models. Thus, the question of changes in North Atlantic storm-tracks with warming remains unanswered.

The main goal of this work is to explore the changes in the North Atlantic storm-tracks in the past decades and to analyze the role of the external forcings on these changes. We will use different sets of atmospheric reanalyses and the climate simulations performed with the climate model CNRM-CM5, built up by the CNRM-CERFACS modelling group as a contribution to CMIP5. To characterize the extratropical cyclones and their tracks, the tracking scheme developed at Météo France by Ayrault (1995) has been used. It is based on the detection of maximum of relative vorticity at 850 hPa.

The algorithm has been applied to the ERA40 and 20CR reanalyses. Even though the 20CR reanalysis covers the whole 20th century, we show, in this study, that it is not adapted to assess trends in the atmospheric fields before 1950, due to some discrepancies in the assimilated observations. However, in the second part of the 20th century, the 20CR reanalysis seems coherent to ERA40.

In a second part, we investigate the effect of external forcings on the North Atlantic storm tracks recent trends in the simulation performed with CNRM-CM5. We compare a control simulation with the historical simulation with all the external forcings have been prescribed. We show that the model fairly well reproduces the storm genesis locations as well as the following tracks. In the historical period (1850-2005), the model shows a decrease in the number of storms in the southern North–Atlantic, while all the forcings (anthropogenic and natural) are prescribed. In the scenario (RCP8.5), the tendency seen in the all-forcings historical run is confirmed and reinforced.

Finally, we use the idealized simulations to study the effects on storm–tracks when only one kind forcing is prescribed in the climate model. Here we show that the response of North Atlantic storm–track is coherent to the one found in the
Impacts of natural external forcings on the Amazon regime rainfall modulated by the tropical Atlantic Ocean during the past millennium

L. Prado (1) ; I. Wainer, (1)
(1) Universidade de Sao Paulo, Instituto Oceanográfico, Sao Paulo, Brazil

Tropical climates are strongly influenced by the moisture influx from the adjacent oceans. In 2005 and 2010, dryness events observed in the Amazon Basin were strongly related to positive anomalies of sea surface temperature over the tropical North Atlantic. These changes in the Amazon water cycle had important consequences to the population, economy and ecosystems. In recent past climates, there is evidence of drier conditions in the Amazon Basin during the Little Ice Age (1400 to 1700 Common Era, C.E.) and wetter conditions during the Medieval Climate Anomaly (950 to 1300 C.E.). These periods were associated with variations of natural external forcings, as the solar and the volcanic forcings. The variability of tropical oceans is influenced by the amount of energy received by the Sun and also to solar eruptions, because both consist of radiative forcings. As the Amazon Basin moisture influx is related to the tropical Atlantic conditions, any changes in this ocean will impact on the Amazon rainfall regime. We will present the effects of the solar variability and the volcanism of the past millennium (850–1850 C.E.) on the tropical Atlantic conditions and consequent impacts on the Amazon rainfall regime. We will use two methods for-downscaling monthly outputs from the National Center for Atmospheric Research–Community Earth System Model (NCAR–CESM) to the past millennium, when natural external forcings prevailed over the anthropogenic forcings. Sea interaction processes in the tropical Atlantic will be estimated from the model outputs, and then related with changes in the rainfall regime over the Amazon Basin. These results will contribute to a better understanding of the natural forcings on the tropical climate.

Impact of climate variability and change on meteorological droughts over Southern South America

JA. Rivera (1) ; OC. Penalba, (2) ; D. Araneo, (1)
(1) Instituto Argentino de Nivología, Glaciología y Ciencias Ambientales (IANIGLACIA), Programa Regional de Meteorología, Mendoza, Argentina; (2) Universidad de Buenos Aires (UBA) – CONICET, Departamento de ciencias de la atmósfera y los océanos, Buenos Aires, Argentina

Droughts are perceived as one of the costliest and least understood natural disasters, given the difficulty in defining its beginning and end, its slow development and its multiple regional aspects. Southern South America (SSA) was used to the annual South American drought index (SADI) and the standardized precipitation index (SPI) was used as a short– and long–term drought indicator. The impacts of climate change on droughts in the region, future time horizon and scenario. These new–linearity was also evident in the temporal behavior of the central Andes and Patagonia. Moreover, links with decadal oscillations as the PDO were identified in the modulation of the decadal component of the annual cumulated deficit volume in the central Andes of Argentina.

The future assessment of precipitation and meteorological drought conditions was performed through a CMIP5 multi–model ensemble based on 15 Global Circulation Models (GCMs) forced under two future scenarios (RCP4.5 and RCP8.5). Changes in meteorological drought characteristics were identified by the difference for early (2011–2040) and late (2071–2100) 21st century periods with respect to the 1979–2008 baseline. Future climate conditions are expected to modify the regional characteristics of meteorological droughts over SSA, but the range of uncertainty in the extent and severity of these impacts is high. A significant increase in the number of drought events for most of the 21st century sub–periods and scenarios is projected for the multi–model ensemble outputs. The mean duration of drought events will be shorter, with no significant changes in the severity of droughts and the occurrence of multi–decadal changes in the number of critical dry months is likely, although the significance in the changes depends on the region, future time horizon and scenario. These results will provide a measure of the likelihood of further drought changes under the CMIP5 framework, which was a key factor of the IPCC’s AR5.

Comparaison de méthodes de réduction d’échelle pour des moyennes et des extrêmes de précipitations au Sénégal

MA. Sarr (1) ; O. Seidou (2) ; Y. Tramblay (3) ; S. El Adlouni (4)
(1) Centre de Suivi Ecologique, Dakar, Senegal; (2) University of Ottawa, Civil engineering, Ottawa, Canada; (3) IRD – HydroSciences Montpellier, Montpellier, France; (4) Université de Moncton, Département de mathématiques et de statistique, Moncton, Canada

Au Sénégal, les chutes de pluie au cours de ces dernières années provoquent régulièrement des dégâts importants dans divers secteurs. Ainsi, il est donc important de comprendre l’évolution future des régimes de précipitations extrêmes pour fournir des outils à la prise de décisions.

Deux techniques différentes de réduction d’échelle ont été appliquées aux sorties de quatre (4) Modèles Climatiques régionaux (MCR) à six (6) stations sélectionnées au Sénégal. La première technique de réduction d’échelle est la méthode Delta–Change. Elle est appliquée sur la moyenne annuelle des précipitations ainsi qu’aux périodes de retour calculées sur 5, 10, 20, 50 et 100 ans sur la base des précipitations quotidiennes. La seconde technique utilise la méthode de transformation Quantile–quante qui permet de modifier les distributions mensuelles de précipitations simulées du MRC et ensuite calculer la période de retour de 5, 10, 20, 50 et 100 ans des précipitations journalières. Les valeurs de précipitations extrêmes sont calculés par l’ajustement de la distribution de GEV. Un test de Kolmogorov–Smirnoff est utilisé pour évaluer la performance de la transformation de Quantile–quante ainsi que l’ajustement de la distribution de GEV pour les précipitations quotidiennes maximales.

Les résultats montrent que les deux méthodes, appliquées aux sorties du même modèle climatique, sont généralement homogènes sur la direction du changement. En revanche, elles conduisent à de différentes projections dans la direction et dans l’intensité du changement des précipitations extrêmes. Entre autres, les projections de la variation des précipitations moyennes sont à la baisse, excepté pour un MRC sur une station. Les changements projetés dans les précipitations extrêmes ne sont pas uniformes ni à toutes les stations, ni à toutes les périodes de retour. Les résultats suggèrent également que le choix de la méthode de réduction d’échelle a plus d’effet sur l’estimation des précipitations quotidiennes extrêmes des périodes de retour égales ou supérieures à dix ans que le choix du modèle climatique.
Bidecadal North Atlantic ocean circulation variability controlled by timing of volcanic eruptions

D. Swingedouw (1); P. Ortega (2); J. Mignot (3); E. Guilyardi (4); V. Masson-Delmotte (5); P. Butler (6); M. Khodri (3); R. Séférian (7)
(1) Université de Bordeaux, UMR CNRS 5805 EPOC, Pessac, France; (2) University of Reading, NCas climate, Reading, United Kingdom; (3) Institut Pierre Simon Laplace, Locean, Paris, France; (4) LOCEAN/IPSL, UPMC case 100, Paris, France; (5) IPI/LSCE, Gif-sur-Yvette, France; (6) University of Bangor, Bangor, United Kingdom; (7) Météo-France, Toulouse, France

Understanding the mechanisms driving Atlantic Meridional Overturning Circulation (AMOC) decadal variability is critical for climate predictability in the Northern Hemisphere. North Atlantic paleoclimate proxy records exhibit variance at the bidecadal scale, but the drivers of this variability remain poorly understood. Here we show that the subset of CMIP5 historical simulations that produce such bidecadal variability exhibit a robust maximum in AMOC strength 15 years after the 1963 Agung eruption, followed by a second maximum in the 1990s, caused by the reset of a bidecadal cycle. The mechanisms at play involve salinity advection from lower latitudes and explain the timing of Great salinity anomalies recorded in the North Atlantic for the 1970s and 1990s. Simulations as well as Greenland and Iceland paleoclimate records indicate that coherent bidecadal cycles were excited following five Agung-like volcanic eruptions during the last millennium. For the last decades, climate simulations and a conceptual model reveal interference patterns associated with the timing of subsequent volcanic eruptions. Destructive interference caused by the Pinatubo 1991 eruption may have led to a stable AMOC in the 2000s. Our results imply a long-lasting impact of volcanic eruptions on AMOC, North Atlantic Ocean and climate, and potentially significant multi-decadal predictability following the next large volcanic eruption.

The CMIP5 GCMs ensemble climate change scenarios for Republic of Moldova's vulnerability and adaptation assessment

L. Taranu (1); I. Bercu (1); D. Deveatii (1)
(1) Climate Change Office of the Ministry of Environment of the Republic of Moldova, Chisinau, Moldova

In the present study we assessed the patterns of climate change computed from global climate model output gathered as part of the Coupled Model Intercomparison Project Phase 5 (CMIP5; Taylor et al., 2012) in temperature and precipitation conditions over the Republic of Moldova (RM) Agro–Ecological Zones (AEZs) as a consequence of the enhanced greenhouse gas (GHG) concentrations until the end of the 21st century. The CMIP5 models are constrained in the North Atlantic for the period 1961–2000. Simulations were created for the period 2006–2099 with the Representative Concentration Pathways (RCP) 2.6, RCP 4.5, and RCP 8.5. The climate change over the RM’s AEZs for the near term (2011–2030), mid-term (2046–2065) and long-term (2081–2100), which are given relative to the reference period of 1986–2005, were considered: the pre-industrial experiment, which not include any external forcing; the Historical experiment, which was obtained forcing models by both, natural and anthropogenic sources, observed between 1850 and 2005; and the Last Millennium which which span the period from 850 to 1850 and is obtained considering the natural forcing estimated for that period. Multi–model ensemble means (MEM) were computed for each experiment over the periods under study.

The Andes Mountains are one of the regions in South America in which paleoclimate studies have been focused on. In particular, in both, the Altiplano, a high–level plateau (around 3800 m), located in the Andes between 15°S and 21°S, and the subtropical Andes, located in central Chile at around 33°S, wetter-than-normal conditions were identified during the 17th century within the period known as Little Ice Age (LIA). On the other hand, drier–than-normal conditions were detected at both regions during the 19th century in association with the more recent global warming period (GWP). Although MEM are capable of representing the thermal changes in South America estimated in both periods, they do not properly represent the precipitation changes, except in the subtropical Andes during the GWP. The large uncertainties associated with the model simulations might be due to their limitations in reproducing the regional precipitation, especially in complex topography. On the other hand, models seem...
able to represent the large-scale circulation changes that would explain the precipitation changes at those two regions in a physically consistent way. It was found that in the Altiplano, wetter (drier) summers in LIA (GWP) seem to be related with a stronger (weaker) upper-level eastward zonal flow in SESA. On the other hand, models consistently show that wetter (drier) winters in the subtropical Andes in LIA (GWP), seem to be associated with a stronger (weaker) westward zonal flow in the low latitudes, induced in turn by hemispheric changes related to a negative (positive) phase of the Southern Annular Mode (SAM).

Southeastern South America (SESA), encompassing the most productive economic areas of 6 different countries (Argentina, Bolivia, Brazil, Chile, Paraguay, and Uruguay), is another region in which available records show a significant precipitation increase by the end of the XX century not only as compared to that observed at the beginning of that century, but also to that estimated by paleoclimatic records at around 700 years ago. Both precipitation and circulation changes simulated by the models at that early period are highly uncertain. However, the MEM for the Historical experiment are able to reproduce precipitation changes as observed in SESA during the GWP, although they are weaker than observed. In fact, most of the simulations reproduce the right sign of the precipitation changes in SESA during that period. However, associated uncertainty ranges (due to both inter-model dispersion and internal climate variability), are still large. In addition, it was found that mean positive precipitation trends in SESA for the Historical experiment are statistically distinguishable from those obtained for the natural-forcing-only experiment made over the 20th century, which exhibit negligible mean values. Results allow concluding that the anthropogenic forcing has at least a partial contribution in explaining the precipitation changes observed in both SESA during the GWP.

### 1103 - Climate variability and external forcings of the Common Era with special focus on the role of volcanic eruptions

#### ORAL PRESENTATIONS

**K-1103-01**  
Robust oceanic cooling trend for 0-1800 CE and the role of volcanic forcing

H. McGregor (1); M. Evans, (2); H. Goosse (3); G. Leduc, (4); B. Martrat (5); J. Addison, (6); P. Mortyn, (7); D. Oppo, (8); M. Seidenkrantz, (9); M. Sicre, (10); S. Phinnos (11); K. Selvaraj, (12); K. Thirumalai, (13); H. Filipsson (14); V. Ersek, (15)

(1) University of Wollongong, School of Earth & Environmental Sciences, Wollongong, Australia; (2) University of Maryland, Maryland, United States of America; (3) UCL, Institut geoges lemaire, Louvain-La-Neuve, Belgium; (4) Centre Européen de Recherche et d’Enseignement des Sciences de l’Environnement et de l’Ocean Pratique, France; (5) IDAEA-CSIC, Barcelona, Spain; (6) US Geological Survey, Menlo Park, United States of America; (7) Universitat Autonoma de Barcelona, Bellaterra, Spain; (8) Woods Hole Oceanographic Institution, Woods Hole, United States of America; (9) Aarhus University, Department of Geoscience, Aarhus, Denmark; (10) CNRS, LOCEAN, Paris, France; (11) ARC Centre of Excellence for Climate System Science, Sydney, Australia; (12) Xiamen University, Xiamen, China; (13) University of Texas at Austin, Austin, United States of America; (14) Lund University, Dept. of geology, Lund, Sweden; (15) Northumbria University, Newcastle upon Tyne, United Kingdom

The oceans mediate the response of global climate to natural and anthropogenic radiative forcing, yet observations of global maritime surface climate variations in the late Holocene, and the mechanisms that drive the variations, are relatively unknown. Here we synthesize SST sea surface temperature (SST) reconstructions, sourced from all major ocean basins, and spanning at high resolution some or all of the past 2000 years. The reconstructions are derived from marine archives (Mg/Ca, alkenones, TEX86, faunal assemblages in sediment cores, and corals), and meet strict chronological control criteria. The reconstructions are geographically sparse, however analysis of multi-millennial AOGCM output and historical gridded SST observations suggest the reconstructions are spatially sufficient to resolve global mean SST.

The reconstructions were standardised into 200–year bins and the resulting Ocean2k SST synthesis reveals a robust SST cooling trend for 0–1800 years of the Common Era (CE), with the strongest cooling after 1100 CE. The cooling trend is not sensitive to localized upwelling, marine archive type, seasonality of response, chronological control, water depth, sampling resolution, salinity, or basin, latitude or hemisphere.

The Ocean2k SST cooling trend is qualitatively consistent with an independent synthesis of terrestrial paleoclimate data, and with simulations from the multimodel PMIP3 ensemble, driven by the full suite of hypothesized radiative forcings. Comparison with ensembles of single and cumulative radiative forcing simulations suggests that the cooling trend arises not from orbital forcing, but from the increased frequency of explosive volcanism and/or land use change in the most recent millennium. We find that episodic volcanism and/or land use change drives the cooling trend, not from orbital forcing that results in a centennial and global-scale cooling trend via a decline in mixed-layer oceanic heat content.

**K-1103-02**  
Climate impacts of volcanic double events during the Common Era

K. Krüger (1); M. Toohey, (2); M. Sigl (3)

(1) University of Oslo, Department of Geosciences, Oslo, Norway; (2) GEOMAR Helmholtz–Zentrum für Ozeanforschung, Kiel, Germany; (3) Paul Scherrer Institut, Villigen, Switzerland

Volcanic eruptions are known to be a major driver of climate variability during the last millennium (the Common Era). Recent high-resolution polar ice core data reveal new insights into volcanic forcing during this period, improving our knowledge of the timing and the amount of sulfur released by past volcanic eruptions (Sigl et al., 2014). Here we focus on the effect of volcanic “double events”, such as the volcanic eruption of Tambora (1815) and Krakatau (Unknown) and 1815 at Tambora. The close temporal proximity of two eruptions creates the potential for climate impacts to superimpose. Ice core records provide evidence of other such double events, and climate proxy records are used to assess the climate impact of double compared to single eruption events. We perform climate model simulations to investigate specific volcanic double events, reconstructed from ice core records, and assess the potential for additive climate impacts. In particular, simulations are used to investigate the impact of decadal scale volcanic radiative and dynamical anomalies on the coupled climate system including vegetation, sea ice and ocean circulation changes. Our model results show that given certain conditions, two closely spaced eruptions of Tambora magnitude could have a larger cumulative climate impact than a single eruption of much greater magnitude. Based on the observational records and model results, we propose that volcanic double events are a likely agent for abrupt (decadal) climate changes, and may have had significant impacts on past civilizations.

Climate change making impacts on societies in the European/Mediterranean region during the past two millennia as seen by land-ocean palaeoarchives

B. Martrat (1); C. Euromed-Ocean2k (2)
(1) IDAEA-CSIC, Barcelona, Spain; (2) University of Cambridge, Earth sci., Cambridge, United Kingdom

A composite of sea surface temperature (SST) reconstructions from the Mediterranean/Eastern Atlantic basins (this study; McGregor et al., 2015, submitted) is compared with a stack of terrestrial records selected to describe the temperature variability in the European region over the past 2000 years (PAGES 2k consortium, 2013, NATURE GEO.). Prior to 800 CE, the scarcity of measurements prevents us from making sound inferences about climatic changes during this interval. From 800 to 1800 CE, both land and ocean signals present common significant cooling trends (up to ~1 s. d. units/millennium, R2~0.67, p<0.01), attributable to the anomalous cold temperatures registered during the Little Ice Age. The latter is a well-documented anomaly, which had strong impacts on European societies and stands out in both composites, particularly in the last centuries. Since 1800 CE, warming has dominated the reconstructions; terrestrial and oceanic simulations suggest that this is consistent with a global warming trend, which arises from increased frequency of explosive volcanism and possible land use change. During the 20th century, the terrestrial composite registers almost +2 s. d. units warming since 1800 CE, in remarkable agreement (R2=0.81, p<0.01) with a reference Central England temperature record estimated independently (Met Office Hadley Centre for Climate Change, 2014). The warming is of lower amplitude in the ocean composite, only +1 s. d. units, in line with historical sea surface temperatures (Kaplan et al., 1998, J. GEOPHYs. RS). The 20th century warming amplitude seems more pronounced as more low-latitude and close-to-land records are taken into consideration, whereas inclusion of high-latitude and/or upwelling locations attenuates it. These uncertainties inherent in the reconstructions available and the variety of responses to climate changes during this interval, the answer to the question whether the last century is likely the warmest climatic period of the last 2000 years appears elusive in the European/Mediterranean region.

Geochronological and Global Climate Impact

M. Sigl (1); J.R. Mcconnell, (2); M. Winstup, (3); G. Plunkett, (4); F. Ludow, (5); C. Kostick, (6); K. Welten, (7); M. Toohey, (8); R. K. Kruger (9); U. Büntgen, (10); M. Baillie, (4); J. R. Pagani, (2); M. Lavigne, (2); and the PAGES 2k consortium
(1) Paul Scherrer Institute, Villigen, Switzerland; (2) Desert Research Institute, Division of hydrological sciences, Reno, United States of America; (3) University of Washington, Department of earth and space sciences, Washington, United States of America; (4) Queen’s University Belfast, School of geography, archaeology & palaeoecology, Belfast, United Kingdom; (5) Yale Climate & Energy Institute, and Department of History, New Haven, United States of America; (6) The University of Nottingham, Department of history, Nottingham, United Kingdom; (7) University of California, Space sciences laboratory, Berkeley, United States of America; (8) GEOMAR Helmholtz–Zentrum für Ozeanwissenschaften, Kiel, Germany; (9) University of Oslo, Department of geosciences, Oslo, Norway; (10) Swiss Federal Research Institute WSL, Birmensdorf, Switzerland

Early documentary records report of a mysterious dust cloud that was covering Europe for 12 months in 536–37 CE, which was followed by climatic downturn and societal decline globally. Tree rings and other climate proxies have only corroborated the occurrence of this event as well as characterized its extent and duration, but failed to trace its origin.

By using a multi-disciplinary approach that integrates novel, global–scale time markers with state-of-the-art continuous ice core aerosol measurements, automated objective ice-core layer counting, tephra analyses, and detailed examination of historical archives, we developed a new volcanic forcing series from bipolar ice–core arrays back into Roman times. We revised the timing of major volcanic eruptions and reconstructed atmospheric aerosol loading and the spatio-temporal distribution of volcanic sulfate and tephra. Precise ice–core timescales for Greenland and Antarctica enabled us to discern tropical from Northern Hemisphere eruptions, and to identify the climate-altering role of non-tropical eruptions, such as those causing the "mystery cloud" in 536–37 CE.

Our study reconciles human and natural archives—demonstrated by the synchronicity of major volcanic eruption dates to historical documentary records and the (now) consistent response of tree–ring–reconstructed cooling extremes occurring in the immediate aftermath of large volcanic eruptions throughout the past 2000 years. These findings have significant implications in multiple research fields, including understanding climate variations to external forcing, and will be of benefit for historians, volcanologists as well as climate scientists.
in aerosol sulfate, is preserved in ice cores. The sulfur anomaly allows identification of eruptions very likely to be stratospheric, with potential climatic impact, regardless to the ice core location, the age or the magnitude of the recorded event.

In 2010–2011, five 100m-long ice cores from Dome C, Antarctica, separated by 1 m, were reconstructed to collect the history of volcanism over the last 2500 years. Assumed volcanic events were identified through sulfate concentration measurements in the field, and located on the cores. We used an algorithm for the peak detection, and 51 potential volcanic events were identified. Based on this detection, a statistical evaluation of the occurrence of these 51 events in each ice core was conducted and allowed measuring the representativeness of a single ice core to reveal a history of volcanism. Following this statistical work, volcanic sulfate contained in snow and ice have been isolated, decontaminated, melted, concentrated and extracted using ion exchange methods. Each presumed volcanic event has been subdivided in 5 fractions at least, in order to differentiate the background isotopic signal from the sulfate peak. The peak itself has been divided into three portions. The results show that Δ33S and Δ34S are anti-correlated, and allow to discriminate stratospheric and tropospheric events, with the former having isotopic systematics that vary first with a positive Δ33S at the beginning of deposition and with a negative Δ33S at the end of the volcanic deposition. Such unique feature should allow us to reconstruct a robust volcanic forcing signal, independent of the size of the event record in ice.


O-1103-05

Effect of large volcanic eruptions on climate variability from inter-annual to decadal timescales: Towards a coordinated modeling assessment

M. Khodri (1) ; C. Timmreck (2) ; D. Zanchettin (3) ; M. Toohey, (4) ; V. Poulin, (1)

(1) IPSL, LOCEAN, Paris, France; (2) Max–Planck–Institute for Meteorology, Hamburg, Germany; (3) University of Venice, Venice, Italy; (4) GEOMAR Helmholtz Centre for Ocean Research, Kiel, Germany

It is now generally recognized that volcanic eruptions have an important effect on climate variability from inter–annual to decadal timescales. At the decadal scale, CMIP5/PMIP3 simulations have highlighted that climatic impacts of eruptions can produce a long–lasting cooling such as during the 13th and the 19th centuries. This has led to the hypothesis that enhanced volcanic activity during the second half of the 13th century played a significant role in the transition towards the Little Ice Age through its impact on the thermohaline oceanic circulation and on Arctic sea ice. This hypothesis remains however speculative, as paleoclimate reconstructions and climate simulations yield partly contradictory results.

Concerning the short–term hemispheric response to sulphur–rich volcanic eruptions, CMIP5/PMIP3 climate simulations show stronger cooling than tree–ring based reconstructions. Scarcie information about the medieval and 19th century eruptions (i.e. magnitude, timing and location) have so far hampered a realistic assessment of the climatic impacts of decadal–paced volcanic events. Another possible reason for the mismatch is our limited understanding of the evolution of stratospheric aerosol formed after strong eruptions of pre–instrumental period, such as Tambora in April 1915, for which no direct observations are available.

It is therefore necessary to frame future modeling activities within common designs that separately tackle the two major steps linking sulfur emissions by volcanic eruptions and climate response: first, the chemical and microphysical transformation occurring within the stratospheric volcanic cloud; then, the aerosols’ direct radiative effects and associated feedback mechanisms activated in the coupled ocean–atmosphere system. The coordinated modeling initiative within VOLMIP (Model Intercomparison Project on the climatic response to Volcanic forcing, an activity for CMIP6) has been motivated by such necessity. VolMIP will provide new constraint data and resolve coupled climate simulations for some of the major volcanic eruptions that occurred during the pre–industrial period of the last millennium.

This contribution presents ongoing activities and research highlights achieved within VolMIP, illustrating how these coordinated modeling assessments are contributing towards constraining uncertainties in the climatic response to volcanic forcing, improving the evaluation of climate models, and advancing our understanding of past, current and future climates.

K-1104-01

USE of Climate Information in the context of helping prepare American military bases for climate change

L. Mears (1) ; M. Rachel (1) ; M. Bukovsky (1)

(1) National Center for Atmospheric Research, Boulder, United States of America

We will describe the work we have performed in two projects through the Strategic Development and Research Program of the US Department of Defense. We are providing future climate information to a total of eight different military bases in the continental US. The kinds of impacts, derived from forced radiative changes due to sea level rise, increased hear stress and potential increased damage from erosion because of increased extreme precipitation, increased extreme fire risk, and potential changes in human systems. We are using four different modeling systems to support these bases. We are providing uncertainty information to the stakeholders (military personnel) are each base, and discuss the different levels of interest or concern we found among the stakeholders based on their prior experience with extreme events.

O-1104-01

Climate Science for Climate Services: Creating capacity within CORDEX-Africa

C. Lennard (1)

(1) University of Cape Town, Climate System Analysis Group, Cape Town, South Africa

Within the Co-ordinated Regional Downscaling Experiment (CORDEX), the Cordex–Africa initiative has been developed to analyze downscaled regional climate data over the Africa domain of CORDEX. The initiative focuses on using climate data analysis techniques and engage users of climate information in both sector specific and region/ space-based applications. A series of engagements between African climate scientists and users of climate information under the CORDEX–Africa banner has begun and we report on the outcomes of these as well as the future plans of the programme. Established and young climate scientists from west, east central and southern Africa have analysed downscaled data from the CORDEX Africa domain and produced 9 scientific journal papers to date through a series of highly successful workshops, all first authored by early–career scientists or students. These papers have greatly enhanced the understanding of climate processes in each of the regions. Additionally, members from each region have been involved in workshops that engage users of climate information to co-explore the climate information needs of these communities. These
included (a) engagements with ecological, hydrological and agricultural scientists that helped refine some of the research questions to be addressed in later CORDEX activities, (b) with health sector practitioners in West Africa to understand their needs with respect to climate impacts and (c) with representatives from five African cities to understand city-scale climate vulnerabilities and information needs. Planned activities include a series of workshops to analyse climate projection data in the 4 regions, with input from climate information users to assess potential effects of global warming on atmospheric process and the impacts these may have in the engaged user communities.

O-1104-02
The FODAS based climate prediction services in China
Z. Gong (1)
(1) Beijing climate center, Beijing, China

The structure of China Framework of Climate Service, what we called CFCS to compare to the GFCS is building in China. Based on climate database and climate system model, climate monitoring and prediction products is issued. We focus on climate security and disaster risk reduction. Climate security is a new concept developed by Dr. Zheng Guogang, who is the Administrator of China Meteorological administration. Climate is really related to food security, water security, energy security and ecological security, and so on. We need to assess climate impact, climate capacity, to synthesize resource and provide climate proofing to support sustainable development of social-economic in china. As China belongs to monsoon climate and is a very vulnerable country suffered from different kinds of meteorological disasters. Therefore, Beijing Climate Center (BCC) are facing big challenge of disaster risk reduction. We need to do disaster survey, to assess vulnerability, to issue risk warning even support risk transfer. Through the user interface plan and partner to provide all of those climate services to decision makers, public community and economic sectors. Besides, in order to support the capacity development of CFCS, the forecast system on dynamical and analogy skill (FODas) is developed by BCC, which is used for supplying monthly and seasonal climate prediction services to the government and public. FODAS is also been generalized in more than 30 provincial climate centers in China and used for regular climate business. We are also working on developing a English version of FODAS to support some international training courses held in CMA etc.

O-1104-03
The fourth generation of European-wide climate change impact assessments – lessons and outlook
HM. Füssel (1); J. André (1)
(1) European Environment Agency, Copenhagen, Denmark

The European Environment Agency (EEA) is a boundary organization that bridges between data providers, scientists, policy communities, and policy makers. Its mandate is to provide timely, relevant and quality-controlled information on the environment to European policy makers (in particular the European Commission and the European Parliament) and national and sub-national policy-makers in its 32 member countries and 7 cooperating countries, and to the broader public. In 2012 the EEA published its third indicator-based report on climate change impacts, vulnerability, adaptation and mitigation in Europe and identifies major knowledge gaps. It also presents the planning of the 2016 EEA report, including efforts for refocussing the indicator set in order to increase its policy relevance, improving coverage of information related to extreme weather and climate events, expanding consideration of cross-sectoral effects, and strengthening links between information on climate change impacts and adaptation-related issues. We also report on past and planned efforts at improving the assessment and reporting of uncertainties in observed and projected climate change and its impacts.

O-1104-04
Innovation in French climate services thanks to service design
P. Dandin (1); L. Corre, (2); D. L’hôte, (3)
(1) Météo–France, Centre National de Recherches Météorologiques, Toulouse, France; (2) Météo–France, Direction de la climatologie, Toulouse, France; (3) Strate, Ecole de Design, Sèves, France

Within the framework of the French National Adaptation to Climate Change Plan, the "Drias, the futures of climate" service was developed to support access to the French regional climate projections. Users worship the unleashing of such essential materials and rank Drias as one of the major recent steps toward the development of French Climate Security. Nevertheless, the original process was not end users. Viaduc project has this target: to evaluate and enhance the user interface plan and partner to provide all of those climate services to decision makers, public community and economic sectors. Besides, in order to support the capacity development of CFCS, the forecast system on dynamical and analogy skill (FODas) is developed by BCC, which is used for supplying monthly and seasonal climate prediction services to the government and public. FODAS is also been generalized in more than 30 provincial climate centers in China and used for regular climate business. We are also working on developing a English version of FODAS to support some international training courses held in CMA etc.

However necessary and successful the initiative might have been, many questions arose. Some came from the scientists whereas others were raised by users. How really useful was this service for end-users and decision makers involved in adaptation planning at local scale? Did it help them to figure out what kind of climate change was happening and what could be thought to cope with it? Had the French scientific community been able to provide all possible efforts and released the information available in the laboratories? Taking advantage of all the assets worked out in the field of climatology, could it be possible to improve the delivery? Did we miss something believing we were doing our best? With many such questions in mind, soon after the opening of the Drias service, a review and reflection exercise was initiated.

The Viaduc project has this target: to evaluate and enhance Drias, as well as to imagine future developments to support adaptation. Users had been closely associated to the building of Drias. The project hence chose to address adaptation with local communities, thinking about real needs at the end users’ level. The chosen end-users are three Natural Regional Parks located in the South-West region of France. Such entities which gather together municipalities defined by a common natural and cultural heritage. They are also rural areas in which economic activities do take place, and therefore concerned and involved in both protecting their environment and setting up sustainable economic development. Climate researchers work together with a scientists’ and end-users network, proposing an innovative approach based on the interaction between scientists and citizens. Actually, the designer observes an innovative approach based on the interaction between scientists and citizens. The Viaduc team did not initiate new actions in the parks, but insert into existing ones, trying to ease them. Three
key local economic sectors have been selected, which are forestry, agro-pastoralism and construction, relevant to each of the parks. Working groups composed of expert technicians, administrative and maintenance staff, politicians and climate researchers have been created. The scientifically supported assessments are relevant to climate risks and concrete actions are now undertaken. They will be presented in this communication, together with lessons learnt. The second part of the project has focused on the transfer of ideas to the operational teams, in order to give life in next generation of products to some of the recommendations that came out of this thinking exercise.

The feedback from the designer and the Viaduc team on the services delivered by scientific agencies and the meteorological service do modify the classical views. It concerns all aspects of the products and services, and addresses various subjects from the relationship between weather and climate, the need for local and perceivable information and messages, to the necessity of a greater coherency and simplicity of the message...

A quick introduction to Drias will be made, and the Viaduc project and outcomes will be presented.

**O-1104-05**

World Weather Attribution: A Real-Time Effort to Assess the Influence of Climate Change on Extreme Weather and Climate Events

H. Cullen (1); M. Allen (2); F. Otto (2); D. Karoly (3); G.J. Van Oldenborgh (4); E. Coughlan (5); and Van (5)

(1) Climatological Center, Princeton, NJ, United States of America; (2) University of Oxford, Oxford, United Kingdom; (3) University of Melbourne, School of Earth Sciences, University of Melbourne, VIC, Australia; (4) KNMI, De Bilt, Netherlands; (5) Red Cross/Red Crescent Climate Centre, The Hague, Netherlands

Climate Central and its partners at the University of Oxford Environmental Change Institute, the Royal Netherlands Meteorological Institute (KNMI), the University of Melbourne, and the Red Cross/Red Crescent Climate Centre have established a new initiative called World Weather Attribution. World Weather Attribution aims to apply recent advances in the science of probabilistic extreme event attribution to build a real-time attribution capability designed to provide objective, science-based connections between extreme weather events and climate change. The goal is to design and implement a coordinated, transparent, multi-method approach that incorporates observational data, modeling studies, existing peer-reviewed research (i.e., IPCC SREX, etc.) and prepare a platform to better address pressing questions about trends in risk and the role of human activity in extreme weather.

Assessing the influence of global warming in individual extreme weather events has been a goal of the scientific community for more than a decade. Advances in the field have prompted numerous studies, leading the Bulletin of the American Meteorological Society (BAMS) to dedicate an annual special issue to extreme event attribution for the past three years. Currently, these studies require months to compile and publish. As a result, the public is unprepared when an event has peaked, and when decisions on how to rebuild, for example, have already been finalized, often without attention to climate information on how risks of such events may have changed over time.

In fact, an analysis of media coverage of three recent extreme weather and climate events (2014 UK floods, 2013 Australian bushfires, 2013 California drought) conducted by Climate Central suggests that, despite strong public interest in better understanding the underlying cause of extreme weather and climate events, a significant majority of extreme event coverage fails to provide the broader climate context. While overall weather and climate coverage results in a large number of stories in the days to weeks following the event, attribution statements are rarely provided and often inaccurate as analyses are not available until several months later, after the media and public conversation is largely over and many recovery and reconstruction decisions have already been made, often based on limited information on changing risks.

Our goal is to apply established peer reviewed methodologies developed by the attribution community over the past decade – in an accelerated manner – so as to objectively assess the event in question and equip journalists, the public and decision makers with the broader context of changing risks, especially those specifically due to global warming. To this end, the World Weather Attribution program will make extensive use of social science through experiments and robust literature reviews on the presentation of risk, in order to reduce uncertainty to guide the most effective deployment and presentation of these accelerated attribution statements. Here we discuss ongoing research that seeks to understand public understanding of the changing story of certain extreme weather and climate events and how best to communicate and attribute attribution information.

**P-1104-01**

Spatialtemporal Visualization Method for Interrelation-based Analysis of Agriculture's GHG Emissions and Agricultural Productivity in Asian Region Using the 5D World Map System

B. Ahmad Muzaffar (1); A. Siti Nor Khuzaimeen (1); S. Shiomi (2); and K. Yasushi (2)

(1) Keio University, Graduate school of science and technology, Yokohama, Japan; (2) Keio University, Graduate school of media and governance, Fujisawa, Japan

According to the Food and Agriculture Organization of the United Nations (FAO), anthropogenic Greenhouse Gas (GHG) emissions originated from agricultural activities have increased approximately two times over the past five decades. Mitigation and adaptation countermeasures must be taken to reduce or slow down the increment of GHG level as a result of unhealthy agriculture practices especially in most developing countries. Conversely, further increment in GHG emissions results in climate change and eventually affects the agricultural sustainability and food security.

To understand the complex system between GHG emissions and agricultural productivity, a regional and historical analysis is compulsory as well as for finding more viable solutions. By applying the 5D World Map system, we demonstrate spatiotemporal visualization to analyze the interrelation between agriculture’s GHG emissions and agricultural productivity. In this analysis, we focus on Asian region since it is one of the largest contributors of global GHG emissions from agriculture sector itself.

The most significant contribution of this research is to unveil the interrelation-based analysis between GHG emissions and agriculture, considering the Asian countries geographical aspect and historical data records. We mapped the pre-sorted text data of Asian countries in Eastern Asia, South-Central Asia, South-East Asia and Western Asia from 1963 to 2013. Then, we visualized and analyzed the data by comparing various attributes, namely; types of GHG (CO2, CH4 and N2O) and annual crop yield. As results, we are able to observe that the spatial pattern of CO2 and CH4 and annual crop yield is quite uniform, but slightly different in N2O emission. The temporally increasing trend of GHG emissions in some countries is observed as expected, as well as the decreasing trend in other country’s, while the distribution of annual crop yield is contrary to expectations. Also, we emphasize the fact from real cases that the interrelation between crop yield and GHG emissions could be observed explicitly by the spatiotemporal visualization of the data. As an insight from these results, we consider to classify these countries into four clusters: 1) cluster with high agricultural productivity and high GHG emissions, 2) cluster with high agricultural productivity but lower GHG emissions, 3) cluster with low agricultural productivity and low GHG emissions and 4) cluster with low agricultural productivity but higher GHG emissions.

In this research, the visualization of specific GHG emission density by each country and its’ crop yield were made possible through the 5D World Map system. The index ranking of each country in each attribute is also visualized. Besides, new knowledge and possibilities existing between climate change and agriculture sector are discovered and
ABSTRACT BOOK

P-1104-02

Connecting the Dots: An Initiative on Communicating Complex Climate Science to Local Communities through Climate Change Services

SK. Amsad Ibrahim Khan (1) ; H. Malleshappa (1) ; M. Jayanthi. (1)
(1) Tamil Nadu State Climate Change Cell (TNSCCC), Department of Environment, Government of Tamil Nadu, Chennai, Tamil Nadu, India

Article 6 of the United Nations Framework Convention on Climate Change addresses the importance of climate change communication and engaging stakeholders in this issue. It highlights the responsibility of participating countries at the national, sub-national and local levels, to ensure public access to information and to promote public participation in climate change. However, this is a significant challenge, particularly for developing countries like India despite of other emergent and on-going developmental challenges. In this context, this article addresses an initiative taken by the Government of Tamil Nadu, India at the local level to address the global challenge of climate change, in a case study approach. The main objective of this contribution is to showcase a method/approach to connect the dots i.e. climate change «science–policy–society» and build capacity by communicating complex climate change science and its information at local level through effective climate change services, particularly, from the perspective of developing country’s initiatives on tackling climate change. Thus, realizing this urgent importance, Tamil Nadu State Climate Change Cell (TNSCCC) at the Department of Environment, Government of Tamil Nadu, India has laid a roadmap as «Tamil Nadu State Climate Change Services (TNSCCS)» based on the guidelines of the Global Framework for Climate Services of World Meteorological Organization (WMO). This framework has initiated a Tamil Nadu State Action Plan on Climate Change (SAPCC) in par with India’s National Action Plan on Climate Change (NAPCC). TNCCS acts as a central hub of information, data and reports about climate change of entire Tamil Nadu state. It is considered as one of the major principal mechanisms through which information about the climate of the past, present and future is routinely archived, analyzed, modeled and exchanged. Tamil Nadu (TN) Climate Knowledge Management System (TNCCKMS) has been established and serves as a store house of locally observed and projected climate change information for the state of Tamil Nadu. Importantly, it provides a “web–based platform” and “user friendly interface” to disseminate and exchange climate change information for various communities ranging from bureaucrats, policy planners, decision makers to farmers, fisher men, students, children, general public and others. It is hoped that the information gleaned from the above mentioned method/approach of climate change services witness how best the complex climate change science can be tailored and communicated at local level. Importantly, it showcases a method/approach on capacity building through effective climate change information and services from global to local level.

P-1104-03

Role of social media networking in Climate policies Awareness in Sub-Saharan Africa

M. Atomofo Aleya (1)
(1) Solidarity for Rural Development and Local Governance in DRC(Tshwane University of Technology), Pretoria, South Africa

Climate policies awareness and/or knowledge are much required for the based-communities to mitigate the risk based on climate change and adaptation. In this respect, to spread awareness and/or knowledge of climate policies amongst African population by using social media is critical in raising ranks of awareness on the consequences related climate change. This research surveys the role of social media networking in contributing to climate change awareness in rural areas especially. African population living in sub-Saharan Africa where the impact of climate change disrupts subsistence farming activities. In fact, Economy in Africa is mainly focused on agriculture and people’s livelihood activities. On the one hand, many Africans are still unaware of climate policies developed neither in the national or international scale that fit with climate change. In the other hand, Aboriginal people living in forest areas have troubles with the access to information and of certain prohibitions to hunt and harvest the wild fruits in parks and other protected areas. That is why, this study found out that, The ubiquitous of internet facilities in African continent based on mobile application are tools that can facilitate information propagation and communication, even though, these technologies practice and abilities are utilised independently by the hands users. As the rural people are vulnerable to climate change, they are also considered as key players for emerging climate policies to mitigate and cope with climate change’s effects. It is a need to use Social media networking in a number of operating ways to follow-on awareness and/or knowledge amongst them. Thus, Climate policies awareness remains the foundation of all other answers to climate change. Therefore, the main objective of this research is to interest African governments to adopt the information and communication technologies such as social media networking to conduct a viral campaign enhancing knowledge and awareness related climate policies and development activities from the perspective of developing countries at the national, sub-national and local levels, to ensure public access to information and to promote public participation. This has been initiated as envisaged in Tamil Nadu’s Climate Services of World Meteorological Organization «Tamil Nadu State Climate Change Services (TNSCCS)» with a special focus on West Africa during the previous and the current monsoon season and the associated scarcity of food and fresh water highlight the importance of accurate predictions of future monsoon circulation for the people of this region.
of the rainy season.

The credibility of regional climate simulations over West Africa stands and falls with the ability to reproduce its key climatic feature, the West African Monsoon. This seasonal shift in large-scale wind patterns plays a pivotal role in every day’s life, and any shift caused by climate change will greatly impact the future of this region. In our analysis, we therefore focus on the representation of the WAM in the regional climate models. For the validation of the models, ERA-Interim re-analysis data is used as lateral boundary condition for the period from 1980 to 2013. We verify the models against observational data from gridded climate observational products such as CPC, TRMM, and CRU. In addition, we employ a novel gridded precipitation database for the West African region, which is compiled from daily and monthly in-situ observations merged from various global and regional meteorological archives (GHCN, GSOD, AMMA, GLOWA) and from precipitation data provided by the national weather services and the novel WASCAL observation network.

In this contribution, we present the overall concept of the WASCAL regional climate projections and provide information on the availability of the data and its dissemination to the community. We discuss the model performance over the validation period for two of the three regional climate models employed, the Weather Research and Forecasting tool (WRF) and the COSMO model in Climate Mode (COSMO–CLM), and give details about the novel precipitation database used to verify the models. We further present results on the climate change signal obtained from the WRF model runs for the periods 2020-2050 and 2070-2100.

P-1104-05

Challenges of scales
S. Huq (1)
(1) International Center for Climate Change and Development (ICCCAD), Dhaka, Bangladesh

There are several aspects of governance related to adaptation to climate change that need to be addressed to ensure equity and fairness in the way adaptation is implemented. Firstly, at the global level, there is the issue of governing climate change funding for adaptation in an equitable manner to ensure that the most vulnerable countries and communities are prioritised for receiving adaptation funds.

Similarly, at national level, it is important for national decision makers to also prioritise the needs of the most vulnerable countries within their countries. This is true for both developing as well as developed countries.

One of the main issues in current climate governance is that the poorest communities within countries, and the poorest countries globally, possess a relatively less important voice in decision making at global and national scales. Hence, in order to adapt successfully to the adverse impacts of climate change, the empowerment of the most vulnerable within the climate governance system is a precondition.

P-1104-06

The Contribution of Climate Services to Climate Change Adaptation through the Global Framework for Climate Services (GFCs)
F. Lucio (1)
(1) World Meteorological Organization, Global Framework for Climate Services Office, Geneva, Switzerland

Climate determines the extent to which human kind can sustain livelihoods and well-being. Thus, as the effects of climate change are becoming more evident and acute, the need for climate services is greater than ever before. Climate services here are considered to be the provision of climate information to assist decision-making in climate sensitive-sectors. Climate services require a series of activities from generating to providing information based on past, present and future climate and its impacts on natural and human systems. These services can range from simple information such as historical climate data sets to more complex products such as predictions on monthly, seasonal and decadal time frames. Ultimately, climate services provide information and expert advice that help users make the right decisions for climate change adaptation.

Seasonal to multiyear climate forecasting has advanced to a point where it can now provide actionable information. Sophisticated climate services combine climate forecasts with information from other sectors to inform decisions on public health, agriculture, water management, disaster risk and other climate-sensitive sectors.

Recognizing the value and contribution of climate services, the international community established the Global Framework for Climate Services (GFCs) at the Third World Climate Conference (WCC-3, 2009) to promote operational climate services at the national and regional levels. The GFCs aims at facilitating the development and use of services to ensure the best efforts to adapt to the impacts of climate-related disasters and to adapt to climate change. It is catalyzing a paradigm shift from supply-driven service production to the creation of demand-driven user needs, by orienting scientific research towards practical applications to respond to those needs. Building on past and current climate service initiatives, it is enabling new services to be developed to increase the value and access to climate knowledge products for those who need them the most.

Climate services underpin climate action and adaptation in climate sensitive sectors; contribute to enhancing disaster preparedness and planning for effective response and to allow societies to build back better after a disaster.

An essential starting point for adaptation is a quantitative assessment combining characterization of hazards with vulnerabilities to derive specific services to various users. This is often hampered by the capabilities to conduct effective analysis of past data and assess changing characteristics and trends of hazards in light of climate change to support risk and impact assessment.

This paper provides an account of how the GFCs is supporting countries in the development and use of climate services for climate change adaptation.

P-1104-07

Appraising the climate services accessible to indigenous communities in Uganda
AR. Mwangi (1)
(1) Makerere University, Kampala, Uganda

Climate change is one of the most pressing challenges of our generation. Scientists predict that it will even have more adverse effects in the future than in the past. Studies indicate that climate change impacts most affect people in the developing countries especially the women, elderly and children because these groups have little access to the information on climate change, they are illiterate and are concealed in poverty. Yet a big constituent of these groups especially the women are by default key resource managers whose knowledge and actions are critical in environment and natural resource management. Climate services are seldom offered in Uganda and as a result climate change is as much abstract to a wide section of people. This study will urge that in circumstances where climate services have been offered they have not been conceptualized for comprehension by the masses. Climate change continues to be portrayed as a highly scientific phenomenon far and above the indigenous communities yet they are the most affected by its impacts. The examples used in talking about climate change are distant and unfamiliar that people hardly make sense of them. Besides climate change is only linked to anthropogenic activities yet natural phenomenon like local land-use changes can have a serious impact.

With data collected through Focus Group Discussions and Key Informant Interviews, this study urges that robust climate services are urgently needed in Uganda to tackle the serious adverse effects of climate change that is changing the local communities through floods and landslides as a result of heavy rains in the Mountain Elgon region have continuously led to fatalities yet the local communities are unaware and cannot devise adaptive and mitigation strategies. Correspondingly the seasons have changed but the local farmers continue to plan their planting seasons basing on the previous seasons that has eventually led to a decline in crop yields resulting into food shortages and its associated ill’s of malnutrition.

ABSTRACT BOOK
Decadal climate information for improved decision-making and resilience in small-scale farming systems in Africa: Lessons from East and Southern Africa

A. Nyamwanza (1)  
(1) University of Cape Town, African Climate and Development Initiative, Cape Town, South Africa

Small-scale farming systems in Africa are facing increasingly erratic and variable climate dynamics, in addition to other multiple and reinforcing non-climatic stresses and shocks. Effective responses and ultimately resilience to these adversities require, among other factors, access to and a readiness of adequate information for the coming seasons and years to enable farmers within these systems to make informed, timely and appropriate decisions not only in the short term, but also in the medium to long term. Climate information is used in agriculture on a range of timescales, from days (weather), months (seasonal outlooks) to decades (climate change scenarios) (Held et al., 2011). In most African countries, adaptation to climate risk has focused either on the seasonal timescale or the assessment of climate change impacts several decades into the future. Awareness of the need to adapt to climate risk at the decadal timescale (up to 10 years) has received less attention. Yet much policy, planning and investment decision-making falls into this time horizon, especially in areas of importance to small-scale farming systems in developing countries such as farm planning cycles, introduction of new varieties and the setting up of such projects as catchment-wide infrastructure for irrigation and water storage (Goddard et al., 2010; Stafford-Smith et al., 2011; Vermeulen, 2012). There is also increasing evidence that climate change is altering the likelihood of extreme events that impact agriculture within the decadal timescale (IPCC 2012). It has been highlighted that this awareness is important in order to assess the utility of climate information in small-scale farming systems in Africa on the decadal timescale. Using cases of small-scale farming systems in the Kilimanjaro Region of Tanzania, the Zambian Valley in Zambia, and the Southern Region of Malawi, the analysis shows decadal climate information as potentially providing opportunities for innovative, flexible and proactive decision-making in response to projected climate and related dynamics. The analysis shows that although farmers will be the major beneficiaries of decadal climate information, other players, particularly service providers and intermediaries, also stand to gain from providing a holistic perspective in dealing with the decision-making context of small-scale farming systems in Africa. The paper however also points to the need for building institutional capacity vis-à-vis the provision of stronger knowledge and information networks between climate scientists, policy makers and local communities as well as attending to issues of credibility, legitimacy and scale in the production and dissemination of decadal climate information in Africa so as to ensure uptake and appropriate use. The discussion, therefore, brings to the fore the need for the recognition of the increasing importance and role of decadal climate information vis-à-vis decision making towards resilient and adaptive small-scale farming systems in Africa.
Climate impacts on health are well established. Building climate smart and resilient communities is therefore essential in the face of climate variability and change. Climate information can play a role in helping societies to better manage health risks brought about by climate variability and change. However, for climate informed health decision-making to become an everyday reality, a broad coalition of partners focused on improved health adaptation and mitigation strategies is essential.

This paper describes the approach taken at the International Research Institute for Climate and Society (IRI) and its partners to integrate research, operational applications and capacity building alongside policy development and advocacy in the area of climate and health in Africa. The initial focus of the IRI’s health work on the development of early warning systems for climate-sensitive diseases (for example, malaria and meningococcal meningitis) was built upon the institute’s applied research capacity in seasonal climate forecasting. However, over time, the agenda has broadened in response to articulated user needs for information on the past, present and future climate to also better understand the mechanisms by which climate impacts on disease, map populations at risk both geographically and by season, develop early warning systems, better understand trends in disease incidence associated with climate shifts and improve the evaluation of the impacts of climate-sensitive interventions.

Central to IRI’s experience throughout has been a keen awareness that climate information and products, in Africa as elsewhere, must be relevant to the health community and development partners and reflect prioritized needs within political and donor processes, while also offering innovations grounded in relevant and reliable observational data obtained through effective, efficient, credible and transparent means. The relevance of this approach to data obtained through effective, efficient, credible and transparent means. The relevance of this approach to data obtained through effective, efficient, credible and transparent means. The relevance of this approach to data obtained through effective, efficient, credible and transparent means.

Beneficial information relayed included daily, weekly and seasonal forecasts, possible disasters, climate stress severity with direct and indirect severe impacts on crop production. It also offered interventional measures of suitable varieties and their productivity potential and appropriate farming activities to be undertaken to reduce, adapt and/or mitigate the negative impacts related to weather and climate.

The use the tool will be out scaled to other counties but also for pastoral communities who will require weather-related information on areas of depressed rainfall, periods of availability, frequency/resurgence of pastures/forage and the likely occurrence of killer diseases and environmental and human degradation. Also necessary is weather information that would cause floods/drought that would drown/kill livestock and potential benefits of using alternative methodologies.

1105a - Assessing climate observations

ORAL PRESENTATIONS

K-1105a-01

Space-based Climate Observing systems

S. Briggs (1); J.L. Fellous (2); P. Lecomte, (1); P. Ultré-Guerard (3); A. Ratier (4); J. Bates, (5)
(1) European Space Agency, Harwell, United Kingdom; (2) COSPAR, Paris, France; (3) CNES, Dps/tcd, Paris, France; (4) EUMETSAT, Director general, Darmstadt, Germany; (5) NCDC, Ashville, United States of America

The Global Climate Observing System (GCOS) provides a framework for the coordination of observations in support of the UNFCCC. The 2003 GCOS Adequacy report to UNFCCC SBSTIA introduced the concept of Essential Climate Variables, variables which were considered fundamental to the understanding and reporting of climate. These were updated in the GCOS 2010 Implementation Plan, and currently comprise a list of some fifty variables. A satellite supplement focussing on the needs of the climate community for observations from Earth observing satellites was produced by GCOS in 2011, and this forms the basis for the current support of space agencies to GCOS. The Commitee on Earth Observation Satellites (CEOS) has formally responded to this with a document published in 2012. Satellite observations are critical for about two thirds of the fifty ECVs. In addition, the Committee on Space Research (COSPAR) has sponsored a roadmap study

K-1105a-02

Climate Observing Systems: Where are we and where do we need to be in the future

C. Baker (1)
(1) NOAA, Oar/arl/attd, Oak Ridge, TN, United States of America

Climate research and monitoring requires an observational strategy that blends long term, carefully calibrated measures as well as short-term, focused process studies. Operating climate observing networks and providing climate services, have a significant role to play in assisting the development of national adaptation policies and in facilitating national economic development. Climate observing systems will require a strong research element for a long time to come. This requires improved observations of the state variables and the ability to set them in a coherent physical (and chemical and biological) framework with models. Climate research and monitoring for Integrated Earth System Science in the period 2015–2025.

This paper will describe briefly the status of the GCOS and highlight the needs for satellite data which derive from it. An overview of current Earth observation satellite systems will be given, together with an analysis of how these contribute to the provision of ECVs. Examples of satellite observations and key derived products for climate will be given.
requires an integrated strategy of land/ocean/atmosphere observations, including both in situ and remote sensing platforms, and modeling and analysis. It is clear that we still need more research and analysis on climate processes, sampling strategies, and processing algorithms.

**K-1105a-03**

**Sea Level, an Essential Climate Variable and an integrator of climate change**

A. Cazenave (1) ; M. Ablain (2) ; JF. Legeais (3) ; B. Meyssignac (1)

(1) CNES, LEGOS, Toulouse, France; (2) CLS, DOS, PMC, Ramonville St Agne, France; (3) CLS, Space Oceanography Division, Ramonville St Agne, France

Sea level is an important climate variable and a major indicator of climate change. In effect, sea level integrates changes and interactions of all components of the climate system (ocean, atmosphere, cryosphere, hydrosphere); it varies globally and regionally in response to internal climate variability and external—natural and anthropogenic—forcing factors. Sea level is one of the 50 Essential Climate Variables (ECVs) defined by the Global Climate Observing System for climate change monitoring and one of the 15 ECVs accurately measured from space within the ESA Climate Change Initiative (CCI) project. While sea level is routinely measured by high-precision satellite altimetry since 20 years, providing a long, homogeneous and accurate sea level record using all altimeters satellites in orbit is the objective of the CCI ‘Sea Level’ project. This allows addressing major issues related to climate change and sea level (e.g., how much is the global mean sea level currently rising? Has it accelerated during the 20th century? Can we close the sea level budget? What are the factors causing non uniform sea level change? Are observed spatial trend patterns due to internal climate variability only or can we already detect the signature of anthropogenic forcing?).

One level products already obtained in the context of the CCCI project have been proved to be superior to other existing products and are of great value for climate change studies. Moreover, combining different CCI-based ECVs (e.g., glaciers and ice sheet mass balances, in addition to the sea level ECV) plus Argo–based ocean thermal expansion leads to better closure of the sea level budget, allowing addressing important new issues, such as the amount of deep ocean warming (not measured by Argo) and its role in the present ‘hiatus’.

Finally, such long, accurate new ECV records are essential to validate climate models used to simulate future changes expected in response to anthropogenic global warming.

**1105b - Quality and availability of data for global sustainability**

**ORAL PRESENTATIONS**

**K-1105b-01**

**Parameterisation, ground-truthing and benchmarking: the importance of in-situ data for global sustainability**

S. Harrison (1)

(1) University of Reading, Reading, United Kingdom

Many key aspects of the global system can only be measured in situ. In situ measurements are required for ground-truthing remotely-sensed products. More importantly, they are vital for developing process-based models and individual model parameterisations. Furthermore, in-situ measurements are used as benchmarks for model evaluation, including the historical and palaeoclimate observations used for out–of-sample model testing. Problematic features of in–situ data include being collected by individuals, using different and evolving methods, and often the same type of data is collected for different purposes. Thus, key steps in using such data are documentation, harmonization and synthesis. There has been considerable progress in creating unified data sets of in situ measurements, but more effort is required specifically in terms of data rescue, data documentation, communal access and data stewardship. Given the utility of in-situ data in developing and evaluating models that are used to predict the likely trajectory of future climate and environmental changes, organisations such as the World Data Service and Future Earth need to provide attention to and support for data rescue, synthesis and sustainability of in-situ data.

**K-1105b-02**

**Future Earth data and information needs**

H. Mario (1) ; D. Ojima (2)

(1) Future Earth Engagement Committee, Future earth, Geneva, Switzerland; (2) Colorado State University and Future Earth US Hub, Natural Resource Ecology Laboratory, Fort Collins, United States of America

Future Earth has been set up as a platform to deliver solution-oriented research for sustainability, linking environmental change and development challenges to satisfy human needs for food, water, energy, health. This will require an effective interdisciplinary collaboration across natural and social sciences, humanities, economics and technology development, to find the best scientific solutions to multi-faceted problems. The main aim is to provide timely information for policy-makers by generating the knowledge that will support existing and new global and regional integrated assessments. Therefore the main stakeholders are a heterogeneous group of researchers (all scientific disciplines) and policy-makers, all of them working jointly in co-designing and co-producing research agendas and knowledge. One particular priority is in developing countries, mainly in support to the Sustainable Development Goals (SDGs).

Recent advances in data collection and analysis provides a unique opportunity to observe, detect and analyze the earth dynamics at multiple scales and across interacting social-ecological system processes. This data explosion has emerged through advances in remote sensing, citizen science networks, and census efforts. These data are being used in ways to enhance our understanding and to inform management decisions on ways to reduce the impact and reducing the harmful consequences and enhancing opportunities as they arise. This information era has benefits to food and water management, response to hazard, forecasting of weather and extreme events, alerting communities of dangers associated with plumes of pollutants, and detecting the presence and movement of rate and sensitive wildlife on land and in the seas. A variety of biophysical and social-economic data sets and observations are available and through coordinated integration provide additional knowledge of the state and transition of social-ecological systems across the globe in order to better inform decision makers.

Such a very ambitious goal requires a wide range of data and information. Jointly with data, it also requires the expert knowledge networks associated with such data. The main challenge is for each individual scientific discipline, to further add value to their data and to re-packaged it, so that it can be understandable, usable and integrated within the data coming from all other disciplines and what is more important accessible to decision makers.

Future Earth hopes to initiate a suite of activities, such as:

- Data inventory, integration, harmonization and experts networks of data-knowledge to support Sustainable Development
- Co-development of data harmonization to facilitate integration of social-biophysical data to derive information on support of transformations toward sustainability
- Assessing data and information needs, and data use in support to the UNFCCC Adaptation activities

Enhancing capacity to enable the flow of interdisciplinary science in support of the decision making process (resilience, water management, sustainable development).
Developing Indicators to Support Climate Adaptation and Sustainability Decision Making
R. Chen (1); A. De Sherbinin (1); M. Levy, (1)
(1) Columbia University, CIESIN, Palisades, NY, United States of America

Every day, decision makers ranging from individuals to governments make important decisions based on composite economic and social indicators on topics such as unemployment, inflation, trade, debt, and prices. These indicators reflect the shared understanding that our global economy is a very complex, interconnected system that operates on multiple temporal and spatial scales. Yet, even though the global environment is at least as complex and interconnected, the global environment—and the current state critical to humanity’s survival—the world lacks integrated indicators of critical environmental systems and climate change that have the quality, reliability, resolution, and relevance to support both individual and collective decision making on both short and long time frames.

We summarize experience to date in developing policy-relevant environmental indicators at global, national, and subnational levels and in tackling a range of scientific, technical, and institutional challenges related to designing and implementing investment in data collection. Despite the integration of environmental, socioeconomic, and health data within a coherent framework of policy-relevant indicators. Such a framework would not only provide justification for continued or expanded investment in data collection and integration, but also a means to prioritize data collection efforts and improve their efficiency and efficacy. As with conventional economic indicators, the development of integrated environmental indicators is also likely to promote their use in both formal and informal decision making in both the public and private sectors.

Marine community initiatives building biodiversity data systems and products in support of global change research
K. Deneudt (1); S. Dekeyzer, (1); B. Vanhoorne (1); L. Vandepute, (1); S. Claus, (1); F. Hernandez, (1)
(1) VLIZ – Flanders Marine Institute, Oostende, France

Global change research requires high quality and readily available biodiversity datasets that are standardized based on internationally accepted standards and can easily be used in integrative analyses that transcend geographic or administrative boundaries. The marine biodiversity community is progressively organizing itself to offer advanced data services and develop quality data products. Diverse aspects of this work are ongoing in the framework of initiatives like the World Register of Marine Species (WoRMS), the Ocean Biogeographic Information System (OBIS), the European Marine Observation and Information Network (EMODNet) project and the LifeWatch European Research Infrastructure on biodiversity and ecosystem research.

The World register of Marine Species is an authoritative list of names of marine organisms. The content of WoRMS is controlled by more than 200 taxonomic experts, each of them responsible for a specific taxonomic group. The register currently holds over 419,000 species names described in literature worldwide, of which 190,400 (45%) were declared as duplicate identities. The register is a key instrument in biodiversity research, as it is used on a daily basis for taxonomic standardization and quality control of biological research and monitoring datasets.

The Ocean Biogeographic Information System is a network of OBIS nodes integrating biogeographic information for marine organisms on a global scale. Individual nodes contribute local or thematic datasets to the global system after standardizing these data based on OBIS and Darwin Core data schemas. OBIS holds 41.92 million distribution records of marine organisms from over 1,700 individual datasets.

In the framework of the LifeWatch taxonomic backbone and the EMODNet biology project large scale efforts are being initiated to collect species traits information and link this ecologic attribute information to WoRMS and OBIS. These recent developments allow the creation of specific tools that have large potential for supporting applied global change research. An example is the World Register of Introduced Species, a newly launched portal that in its current state already lists over 1,400 introduced and invasive alien marine species worldwide, compiled through study of over close to 2,500 publications and collaboration with related international initiatives. In the framework of EMODNet a series of DIVA interpolated gridted abundance maps is being created for selected species reconstructing remarkable distribution patterns over time.

The generated data products are of direct relevance to global change studies on aspects like species distribution shifts, species extinction and migration, exploitation of ocean ecosystems and fish stock collapse, etc...

Multi-Disciplinary Framework for BioEner- gy Assessment
W. Hugo (1)
(1) ICSU-WDS, SAEO/N, Western Cape, South Africa

The BioEnergy Atlas for South Africa is the result of a project funded by the South African Department of Science and Technology, and executed by SAEO/N NRF with the assistance of a number of collaborators in academia, research institutions, and government.

Bioenergy assessments have been characterized in the past by poor availability and quality of data, an over-emphasis on potentials and availability studies instead of feasibility assessment, and large scale evaluation in competition with alternatives – both competing bioenergy resources and other renewable and non-renewable options. The BioEnergy Atlas addresses some of these deficiencies, and identifies specific areas of interest where future research and effort can be directed.

We develop an approach that successively constrains biomass that is potentially available within environmental, social, financial, technical, and economic constraints, leading to an objective selection of appropriate feedstocks, land allocation, technology, and feasible projects for detailed investigation. We discuss methodology, availability of biomass and potentials, and the feasibility results of four case studies in respect of biomass application: (1) co-firing of woody biomass for electricity generation; (2) use of oil bearing crops for biodiesel production, (3) applications for organic components of domestic solid waste and wastewater; and (4) use of woody biomass as a feedstock for an existing GTL refinery.

Findings include
- Availability is not a fixed quantum. Availability of biomass and resulting energy products are sensitive to both the exclusionary measures one applies (food security, environmental, social and economic impacts) and the price at which final products will be competitive.
- Availability is low. Even without allowing for feasibility and final product costs, the availability of biomass is low.
- Waste streams are important. There are significant waste streams from domestic solid waste and sewage, some agricultural production, and commercial forestry.
- Rural firewood use is problematic. This is a significant resource, plays a large role in the energy budget of poor and rural households, and current use means that it will have little impact on the GHG emissions balance.
- Process technologies are not all mature, cost-competitive or efficient: We have investigated 52 different process technologies in respect of costs, economy of scale,
energy efficiency, greenhouse gas emission and job creation impacts, and maturity of technology.

- Solutions are probably ‘packages’. One has to balance the diversity of available resource streams and processing technologies against the need to focus resources on development of critical mass (workforce skills, support industries, expertise). Combining feedstocks and aligning with other government initiatives or subsidies can achieve such critical mass more easily.

- Solutions must be robust in future too. Feasibility studies that focus on the current situation only ignore the fact that future sustainability is strongly dependent on assumptions on relative economic growth (influences household and industrial energy consumption, and the limiting cost for energy), cost of capital and industrial actors’ choices of large-scale or small-scale (or costal-intensive industries), exchange rates and fossil fuel prices (huge effect on selection of alternatives).

- The most promising biomass source is medium-term mining and eradication of invasive alien plants, but this source is limited in time and, if exploited as proposed, will not be available after about 20 years.

There is a need to focus research and development efforts in respect of specific technology/ feedstock combinations that show future promise.

O-1105b-04

Soil data harmonisation and geostatistical modelling efforts in support of improved studies of global sustainability

N. Batjes (1) ; B. Kempen (1) ; J. Leenaars (1) ; R. Vandenbossche (1)

Future Earth and other large international research and development programmes aim to provide the scientific evidence base required for developing into a sustainable future. Soil, which is an important provider of ecosystem services, is one of the least developed data in global land models and uncertainties are large. In this context, there is a pressing need for improved, quality-assessed soil information at multiple scale levels. ISRIC – World Soil Information, in its capacity of World Data Centre for Soils within the ICUS World Data System, is developing inter-operable web-based facilities aimed at facilitating collaborative soil mapping. The Global Soil Information Framework (GSoil) provides a global spatial framework for collating, standardising resp. harmonising, and analysing soil data profile obtained from disparate sources. At present, the facility includes a 3D soil information services for 1 km resolution (SoilGrids1km), which draws on analytical data for some 100,000 soil profiles and over 70 co-variate layers representing soil-forming factors. Global regression models were used to predict values (mean and 90%-confidence interval) for selected soil attributes (e.g. soil pH, clay content, bulk density, and organic carbon content) for six depth intervals up to a depth of 2 meter. Cross-validation for the initial run showed prediction accuracies of 23%-51%, which is promising. Being based on reproducible automated procedures, the geo-statistical predictions are improved on a regular basis. New releases will consider a larger coverage (future harmonisation), is the World, as collated and shared for example within the broader collaborative framework of the Global Soil Partnership (GSP), as well as more advanced geo-statistical approaches that are currently tested. Specific confidence limits generated by the SoilGrids model may be used to assess the impact of uncertainty in soil property predictions (means) during scenario/model testing — data are freely available for visualisation and download at http://soilgrids.org. The SoilGrids procedure has already been applied at various resolutions, depending on specified user needs. For example, a 250m product in support of future CO2 emission modelling (technical resolution 0.5 by 0.5 arc degree) product for Global Land Models that underpin IPCC-related assessments. Further, development of the overall system is already catalysing institutional collaboration and data sharing between national soil institutes around the world on data collection and sharing, data screening and harmonisation, mapping and the subsequent dissemination of the derived information will be essential to create ownership of the newly derived soil information as well as to create the necessary expertise and capacity to further develop and test the system. This system can also be used as the basis for a distributed system, where national soil institutes build and provide standardised databases and digital soil maps for their respective regions. The SoilGrids-derived information will be essential in monitoring our climatic footprint as thecosystem operating in the Earth’s cryosphere and their interactions with climate are tightly coupled. A change in one of its component will drive change in another. To improve our understanding of how changes in climate drive and modulate these changes and how feedback processes in the cryosphere affect climate requires continuation of long-term satellite observations, intensive field and airborne campaigns and new ways to analyze observational data. To combine them with large-scale Earth system models. Polar science has historically involved interdisciplinary research programs, and the collection and management of large, diverse data sets.

The National Snow and Ice Data Center (NSIDC) at the University of Colorado at Boulder is a primary archive for snow and ice data in the United States. NSIDC’s mission is to improve understanding of the Earth’s frozen realms. This includes floating sea ice, lake ice, glaciers, ice sheets, snow cover, and frozen ground, collectively known as the cryosphere. The NSIDC Distributed Active Archive Center (DAAC) is one of NASA’s Earth Observing System Data and Information System (EOSDIS) Data Centers archiving, documenting, and distributing data from NASA’s Earth Observing System (EOS) satellites and field measurement programs. NSIDC DAAC data management involves activity at all stages of the data lifecycle, from planning through acquisition, preservation, publication, and distribution. A key goal for NSIDC is to meet our data user needs in a way that facilitates data use. This is accomplished through improvements in data inter-operability, usability, data searching, and visualization and analysis tools.

O-1105b-06

The World Data Service at the University of Colorado Boulder and National Snow and Ice Data Center: Data and services supporting science

L. Yarmey (1) ; R. Duerr (1)

(1) WDS-CUB National Snow and Ice Data Center, Boulder, CO, United States of America

The World Data Service at the University of Colorado Boulder (UCB) is led by the National Snow and Ice Data Center (NSIDC) is a leader in connecting data and science. These connections are built through targeted programs brought together under the NSIDC umbrella categorized into three high-level categories: curated data products, research partnerships, and cyberinfrastructure research and development. The 432 datasets in the WDS-UCB/NSIDC catalog include some of the most popular and visible datasets at the Data Center, for instance the NOAA/NSIDC Climate Data Record of Passive Microwave Sea Ice Concentration as well as decades-long sea ice extent, concentration, and thickness time-series. The Frozen Ground Data Center at WDS-UCB/ NSIDC is in the process of being updated and integrated with the new Global Terrestrial Network for Permafrost System. In-situ field data such as from the Snow Data Assimilation System (SNOWDAS) are available alongside products such as the MODIS Mosaic of Antarctica image map. All of the digital datasets are augmented by critical legacy data often in analog form, for instance the global Glacier Photo collection as well as many resources from...
the rich history of the International Geophysical and Polar Years.

Ensuring a strong connection with not only scientists in both the data contributor and data re-user roles, but also the general US public and indigenous Arctic communities, WDS-CU researchers maintain tight partnerships with stakeholders communities. The Exchange for Local Observations and Knowledge of the Arctic (ELOKA) program has spent years building relationships that support and connect Community-Based Monitoring programs embedded in Arctic communities with each other and with environmental scientists. Projects looking to document sea ice knowledge, partner WDS-UCB/NSIDC researchers with shipping operations, Arctic community, and semantic experts to map understandings and advance understanding across different perspectives. A growing Arctic social science data program at WDS-UCB/NSIDC reaches out to another domain community to expand interdisciplinary context and participation in data sharing efforts. Connecting WDS-NSIDC resources to stakeholder communities requires clear communication and a shared understanding of use cases and stakeholder needs. An emphasis on usability work with website interfaces has improved connections and communication of content.

Supporting and leveraging both the management of well-described data holdings and tight connections with partners and stakeholders, WDS-UCB/NSIDC maintains a strong cyberinfrastructure research and development focus. Expertise in metadata and data brokering enables distributed data search and has been showcased in diverse venues over recent years. Web crawling for science data of relevance moves the community closer to ubiquitous data discovery. Once relevant data are found, reading and analysis tools support data use and integration for new scientific discoveries.

All of these targeted programs and more come together under the virtual umbrella of the WDS-UCB/NSIDC. Active participation in the WDS community and connections to the many aligned WDS activities and systems are key to advancing our common vision.

1105 - POSTER PRESENTATIONS

P-1105-01

WDC - Solar Activity/BASS2000

J. Aboudarham (1) ; X. Bonnin (1)
(1) Observatoire de Paris, LESIA – Ov Paris, Meudon, France

The understanding of space weather, solar–terrestrial relationship as well as the possible correlation with Earth’s climate is related to the possibility to study long-term behaviors. World Data Centre for Solar Activity BASS2000 (http://bass2000.obspm.fr) provides added–values on solar activity that can be used for such studies. It provides daily observations of the Sun for about 20 years, and older images, starting in 1919 are currently digitalized.

Moreover, in collaboration with the European HELIO project, a features catalogue has been developed giving detailed information on various solar and heliospheric features (filaments, prominences, sunspots, active regions, coronal hole radio sources, type III bursts) for near 20 years also for some of them. And previous data have been digitalized from tables obtained from the Synoptic Maps of Solar Activity since 1919. When the insertion of those data in the features catalogue will be done, nearly one century of data will be available, providing the longest time signature of Solar activity, with around 8 solar cycles available.

P-1105-02

The role of the GCOS Reference Upper-Air Network (GRUAN) in climate research

G. Bodeker (1) ; M. Sommer (2) ; R.Dirksen, (2) ; P. Thorne, (3)
(1) Bodeker Scientific, Alexandra, New Zealand; (2) Deutscher Wetterdienst, Lindenberg, Germany; (3) Maynooth University, Department of geography, Maynooth, Ireland

Measurements of primary state variables of the troposphere and stratosphere (primarily temperature, water vapour and pressure) are typically made to provide the input required by numerical weather prediction models. These same measurements then also constitute the primary source for meteorological reanalyses and climate analyses. The balloon-borne, ground-based and satellite-based systems used to make these measurements often undergo changes in instrumentation, data processing methods, retrieval techniques, and calibration. These changes are often poorly documented and very seldom are measurement series reprocessed to ensure long-term homogeneity of the climate data record. Such unphysical discontinuities in measurement can lead to deterioration of the quality of meteorological reanalyses. To address this specific deficiency of the global network of upper-air observations (GCOS) and GCOS called for the establishment of a new state-of-the-art global network of high quality measurements of essential climate variables in the upper atmosphere, through the 2004 GCOS Implementation Plan (GCOS-92). The establishment of GRUAN (GCOS Reference Upper-Air Network) is now underway and sites are providing reference quality measurements that adhere to GRUAN operating protocols.

This presentation will provide an overview of the achievements of GRUAN to date as summarized in Bodeker et al. (in press 2015). It highlights:

- the protocols that have been established to ensure that measurements are of reference quality;
- what measurement systems are (and will be) operating at GRUAN sites;
- what data products are expected to flow from those systems;
- the data currently flowing from GRUAN sites, technical advancements within GRUAN to meet the needs of user of GRUAN data products; and
- research that has been conducted in support of GRUAN operations.

A network expansion workshop held in June 2012 provided a scientific context for the expansion of GRUAN and this presentation will include an update on how the outcomes of that workshop have guided GRUAN expansion efforts. The goal of GRUAN is not only to produce long-term, carefully calibrated measurements with well-defined measurement uncertainties, but to also produce high quality data suitable for focussed process studies. How GRUAN balances operational and research goals will be included in the presentation. A key user of GRUAN data is the satellite calibration and validation community. Progress within GRUAN to meet the needs of this community will also be addressed. The presentation will finish with an overview of the challenges that GRUAN faces and plans for overcoming those challenges.

References


P-1105-03

A Climate Observatory in South West Indian Ocean: The Maïdo Observatory in La Réunion. Current achievements and Future Prospects

JP. Cammas (1) ; C. Barthe (2) ; E. Blanc (3) ; C. Brognez (4) ; A. Colomb (5) ; V. Duliot (1) ; P. Goloub (4) ; A. Hauchecorne (6) ; M. Kaebernick (7) ; N. Kaempfer (8) ; P. Keckhut (8) ; G. Payen (1) ; T. Portafaix (2) ; F. Posny (2) ; M. Ramonet (9) ; J. Sciare (9) ; K. Selligeri (5) ; P. Tulet (2) ; F. Vimeux (9) ; DBJ. Leclair (1);
MM. De (10)
(1) CNRS & Université de La Reunion, OSU- Reunion, Saint Denis de la Reunion, France; (2) CNRS & Université de La Réunion , Lacy, Saint Denis de la Réunion, France; (3) CEA, DASE, Arpajon, France; (4) CNRS and Université de Lille, Loa, Lille, France; (5) CNRS and Université Blaise Pascal, Lamp, Clermont-Ferrand, France; (6) CNRS, Laïmos, Guayancourt
Satellite-derived aerosol climate data records in the ESA Aerosol_cci project

G. De Leeuw (1); T. Holzer-Popp (2); S. Pinnock, (3); G. De Leeuw (4)

(1) FMI & UHEL, Climate Research / Physics, Helsinki, Finland; (2) DLR German Remote Sensing Data Center (DFD), Oberpfaffenhofen, Germany; (3) European Space Agency (ESA), Brussels; (4) FMI, Climate research, Helsinki, Finland

Within the ESA Climate Change Initiative (CCI) project Aerosol_cci (Phase 1: 2010 - 2014; Phase 2: 2014 - 2017) intensive work has been conducted to improve algorithms for the retrieval of aerosol information from European satellites AS-T2 (ERS-2), AATSR (3 algorithms), MERIS (1 algorithm), SPIRIT, SCIAMACHY, AATSR-2 and AATSR Savers (all on ENVISAT), PARASOL and OMI (EOS-Aura) (both part of NASA's A-Train). Whereas OMI and GOMOS were used to derive absorbing aerosol index and stratospheric extinction profiles, respectively, AERol Optical Depth (AOD) and Ångström coefficient were retrieved from the other sensors. The cooperation between the project partners, including both retrieval teams and independent validation teams, has led to significant improvements in the retrieval algorithms. In particular, the AATSR retrieved AOD is qualitatively similar to that from MODIS, usually taken as the standard, MISR and SeaWIFS. This conclusion has been reached by several independent groups for three different sensors, the L2 and L3 products. Using AERONET sun photometer data, as the standard ground-truth, both ‘traditional’ statistical techniques and a ‘scoring’ technique based on spatial and temporal comparisons were applied. Quantitatively, the limited AATSR swath width of 512km results in a smaller amount of data. Nevertheless, the assimilation of AATSR-retrieved AOD, together with MODIS data, contributes to improving the ECMWF / MACC climate models. In addition to the multi-spectral AOD, and thus the Ångström Exponent, also a per-pixel uncertainty is provided and validated. By the end of Aerosol_cci Phase 1 the ASTR algorithms have been transferred to the operational environment, resulting in an AOD time series of 17 years dating back to 1995.

In phase 2 this work is continued with a focus on the further improvement of the ASTR algorithms as well as those for the other instruments and algorithms, mentioned above, which in phase 1 were considered less mature. The first efforts are on the further characterization of the uncertainties and on better understanding of the cloud screening in the various algorithms. Other efforts will focus on surface treatment and possible improvement of aerosol models used in the retrieval. A yearly re-processing of the full 17-year global ASTR-2/AATSR data set with three different algorithms is planned to evaluate the impact of each of the instruments is approved and belongs to international networks like NDAAC (Network for the Detection of Atmospheric Composition Change), SHADOZ (Southern Hemisphere ADDitional Ozonesondes), the Global Atmosphere Watch/World Meteo- rological Organization (GAW/WMO). In situ analysers group measurements of reactive and greenhouse gases, and aerosols measurements approved by or applying to networks like GAW/WMO (Global Atmospheric Watching / World Meteorological Organization), ICOS (Integrated Carbon Observing System). The Maïdo observatory is currently the only way to provide remote and in situ atmospheric observations at subtropical latitudes and at high resolutions (seconds in time, few tenths of meters vertically) over a marine–remote region poorly sampled by other programs. It provides data for users in science and policy including air quality forecasting, verification of CO2 emissions and Kyoto monitoring, numerical weather prediction, and validation of global chemical transport model, global climate chemical models and satellite products. Since its participation in ongoing European projects (NORS, ACTRIS–2, ARISE–2), and thanks to the start of delivery of data in near real time, the Maïdo observatory will largely contribute to the Climate Change Initiative (CCI) of the (ICAMS). The Maïdo observatory is open to transnational access thanks to its participation in european programmes like ACTRIS–2 and ENVIRplus. This presentation will give an overview of the cooperation with the AATS and the results which illustrate the promise Maïdo observatory data hold for the future, allowing new applications and analysis for a broad community of users.

P-1105-04
Satellite-derived aerosol climate data records in the ESA Aerosol_cci project

G. De Leeuw (1); T. Holzer-Popp (2); S. Pinnock, (3); G. De Leeuw (4)

P-1105-05
Expanding the Network of Precise Seawater Temperature Measurements for Fiji Coral Reefs

A. De Ramon N’yeurt (1); C. Whippy-Morris (2)

(1) The University of the South Pacific, Pacific Center for Environment and Sustainable Development, Suva, Fiji; (2) The University of the South Pacific, Institute of marine studies, Suva, Fiji

As part of the Pacific-wide ReefTemps Monitoring Network, the University of the South Pacific in collaboration with the South Pacific Integrated Observatory for the Environment and Terrestrial and Marine Biodiversity (GOPS) and the Institut de Recherche pour le Développement (IRD), deployed for the first time high-precision (+/- 0.001°C) SBE–56 thermistors in Fiji waters since November 2012.
Aerosol optical properties and dynamic variability of climatic seasons in west Africa: Case study of Ouagadougou

B. Korgo (1); J.C. Roger (2); J. Bathiebo (3)  
(1) University of Ouagadougou, Physique, Ouagadougou; Burkina Faso; (2) University of Maryland, Geography, Washington, United States of America; (3) University of Ouagadougou, Physics, Ouagadougou, Burkina Faso

We present in this paper a climatological study of the optical properties of the atmosphere in West Africa. Using the measurement and photometric inversions data of AERONET in Ouagadougou, we analyze the main optical characteristics such as optical thickness, Angstrom exponent, the single scattering albedo and the asymmetry factor. These properties give quite varied information about the size and chemical nature of atmospheric aerosols in West Africa, particularly in the Sahel region. A study of different variabilities of these properties on a monthly and yearly scale, shows a strong connection with the seasonal succession of dry period marked by the predominance of harmattan winds from the Sahara Desert, laden with dust and wet period characterized by the thrust of the monsoon flow laden with moisture, specific to this part of the world. The low-resolution maps of these atmospheric variables coupled with the dynamics of West African climate allows monitoring of the ascent to the north of the intertropical front marking the beginning of the wet season and the coming of the harmattan winds at the end of this season. An appropriate positioning of AERONET photometric measurements points can allow a long-term monitoring at the regional level of the beginning, the end and the length of seasons and as such appears as a real tool for monitoring climate change in West Africa.

Geospatial land use analysis and its relation to the climate change

M. Lavreniuk (1); A. Shelestov (2); N. Kussul (1); S. Skakun (3)  
(1) Space research institute NASU-SSAU, Kyiv, Ukraine; (2) National University of Life and Environmental Sciences of Ukraine, Kyiv, Ukraine; (3) Integration-Plus Ltd, Kyiv, Ukraine

Land use analysis plays an important role in studying and understanding processes in ecosystems and solving many applied problems based on satellite monitoring. In particular, it allows to improve the accuracy of classification and areas estimation and to analyze climate change and its impact on agricultural production and whole biosphere. Since the 1980s there are many land use datasets based on satellite images, but they had low spatial resolution and accuracy. Also, in 2013–2014 years, several global maps have been made available, but they are not accurate enough at regional level. Low-resolution maps underestimate or overestimate certain land cover types. Therefore, creation of global and regional land cover maps based on high-resolution satellite images (such as Landsat at 30 m) is an extremely important task. In this study, we produced land cover maps for the whole territory of Ukraine based on the Landsat-4/5/7 images for three decades: 1990s, 2000s and 2010s. These maps allow estimation of the general trends of land cover/use in Ukraine and discovering how geospatial land use influence on the climate change. This paper discusses methodological aspects and respective maps of land cover based on Landsat images at regional scale, including all preprocessing steps for satellite imagery, formation of training and test sets, classification method and result analysis.

Training (50%) and test (50%) sets consist of six main land cover classes: artificial surface, cropland, grassland, forest, bare land and water. We formed sets using a photo
interpretation method with uniform spatial distribution over the target territory and proportional representation of all classes. Images contained six spectral bands and three bands with shadow, cloud and cloud contours masks. We selected images with less than 50% of cloud cover for classification. We calculated the distribution of the input pixel values for the three time periods and improve quality of maps comparing overall classification accuracy of 95% for three different neural networks, namely multilayer perceptrons (MLPs) and such an approach has been provided better result than single neural network. After classification, each neural network gave a posteriori probability of the input pixel belonging to each class. In an ensemble, we estimated the average a posteriori probability from all networks and assign to the pixel class with the highest probability.

We estimated the accuracy of classification on independent test set. The overall classification accuracy achieved in the study was approximately 95%. Accuracies for each individual class were more than 70%. The lowest accuracy was for grassland since it is difficult to separate grassland from cropland. At the same time, we compare the obtained areas and official statistics for each oblast and for the whole territory of Ukraine for each time period (1990, 2000, 2010). In addition, we compared the accuracy of our classification for Ukraine with global land cover maps for 2000-2010 at 30 m resolution. The overall classification accuracy for Ukraine was 5% higher than Globeland30–2010. Accuracy of grassland classification was +1% (producer accuracy) and +4% (user accuracy) better than Globeland30–2010.

This paper presented a retrospective land cover mapping methodology for the territory of Ukraine based on Landsat data. The proposed methodology involved classification of multi-temporal satellite images with neural networks on previously restored cloudy pixels. The map was produced for the whole territory of Ukraine. The use of the proposed approach allowed us to achieve overall classification accuracy of 95% for three different time periods and improve quality of maps comparing to other land cover maps available for Ukraine, namely Globeland30–2010. At the presentation the results of climate changes influence on land use will be discussed in more detail.


P-1105-09

The BIOMASS satellite mission: quantifying global biomass, an essential variable of the climate system

T. Le Toan (1); C. Ciais (2); S. Quegan (3); K. Scipal (4)
(1) CESBIO, Toulouse, France; (2) IPSL, Lsce, Gif sur Yvette, France; (3) University of Sheffield, Sheffield, United Kingdom; (4) ESA, Estec, Noordwijk, Netherlands

Quantifying the global carbon cycle is essential to understanding many of the changes taking place in the Earth system and improving future projections. There is strong evidence that over the past 50 years, the land biosphere has acted as a net carbon sink, removing from the atmosphere approximately one third of the CO2 emitted by fossil fuel combustion. However, the status, dynamics and carbon stocks of the terrestrial biosphere are the least understood and most uncertain element in the carbon cycle. Coupling between the terrestrial carbon cycle and climate has been identified by the IPCC as one of the major knowledge gaps in the understanding of carbon stocks and carbon exchange, in the estimates of carbon emissions due to forest disturbances, and in the uptake of carbon through forest growth. A fundamental parameter that needs to be accounted for is the spatial distribution of the terrestrial biosphere, namely for carbon stocks and forest cover. BIOMASS will measure and map forest carbon stock, as well as forest height, over tropical, temperate and boreal forests at a spatial resolution of around 200 m every 6 months throughout the five years of the mission. However, the particular focus is on the carbon-rich dense tropical forests which contribute by far the largest current stock of biomass, but also the largest proportion of carbon emissions from deforestation and forest degradation. By using the combination of three measurement techniques, namely polarimetric SAR, polarimetric interferometric SAR and tomographic SAR all using the same sensor, will significantly reduce the uncertainties in biomass retrievals and contribute to meeting the target of 20% accuracy in AGB at a resolution of 200 m. The spatial consistency of these products together with their provision as time series, means that they will contribute significantly to improving the understanding of the carbon cycle and better quantifying dynamic spatial processes in the world’s forests. These BIOMASS products can also be used as unbiased reference data for national reporting for initiatives such as REDD+

Comparing BIOMASS data with biomass calculated by carbon models, or assimilating biomass in those models, will provide a way of testing the models and also give indications on the sources of discrepancy. Comparison of existing models indicates that they are very dissimilar regarding the absolute magnitude of biomass and its spatial distribution, and that a large part of the misrepresentation of biomass comes from the lack of considerations of disturbances and land use change and incorrect modeling ecosystem processes such as mortality.

The paper will present an overview of the BIOMASS mission, and will discuss the use of BIOMASS data to improve forest productivity modeling and to allow forcing of Dynamic Vegetation Model simulations under future climatic scenarios.

P-1105-10

The Pacific Islands Global Climate Observing System (PI GCOS): Where to Next?

PF. Lefale (1); HJ. Diamond, (2)
(1) Bodeker Scientific, Wellington, New Zealand; (2) Victoria University of Wellington, Geography department, Wellington, New Zealand

The Tropical Western Pacific (TWP) is the ‘ground zero’ of the global climate, one of the largest natural drivers of the climate system; the biggest ocean on the planet, including the El Nino Southern Oscillation (ENSO), the Pacific Decadal Oscillation (PDO). Despite this, the TWP is one of the least observed and monitored regions of the world. Yet, the needs for climate system monitoring, climate change detection and monitoring the impacts of and the response to climate change, especially changes in the distribution and mean sea level rise, and research toward improved understanding, modelling and prediction of the climate system are fundamental in understanding the properties and evolution of the earth’s climate system.

The Pacific Islands--Global Climate Observing System (PI--GCOS) is one of only a few international-sponsored regional programs established in the early 2000s to assist...
Pacific Islands and the international scientific community to observe and monitor the TWP region. The PI GCOS program started in Apia, Samoa, in 2000. It is a sub-program of the international GCOS aimed specifically at meeting climate and related observing needs of Pacific Islands. One of the Apia GCOS workshop, combined with the findings and recommendations of the Secretariat of the Pacific Regional Environmental Program (SPREP)/World Meteorological Organization (WMO) led Pacific Meteorology and Energy (PMSE) project (PMSONAP) report in 2000, provided the foundation for the development of the PI GCOS Program. As a result, a PI GCOS Action Plan (Salinger et al., 2002) was developed hosted by the SPREP in Apia, Samoa from 2004 to 2012 to address these needs in a short strategy document (see http://www.wmo.int/pages/prog/gcos/documents/PI-GCOS-AP.pdf). The PI GCOS Action Plan was re-established by the SPREP in Apia, Samoa from 2004 to 2012 to manage the program. Unfortunately, due to a lack of sustained resources, the program was only active until 2012 at which point it went dormant.

This presentation will summarise key preliminary findings & recommendations of the Review of the PI GCOS (“the Review”) that is currently underway to look at resurrecting the program on behalf of the region as part of a formal bilateral climate activity between New Zealand and the United States agreed to in September 2014. The Review assesses the balance and relevance of the PI GCOS, its achievements, relations between PI GCOS and partner organisations and Members, its functions and governance mechanisms, and vision and future plans. The Review arises from the realization that there is an urgent need to re-establish the PI GCOS Program in light of the increasing demand for climate and related services in the Pacific Islands and internationally. The need for improved climate monitoring and related services in the Pacific, the region has also been identified and if efforts such as the delivery of climate monitoring, research and services in the Pacific through the UNFCCC, the IPCC and Global Framework for Climate Services (GFCS) are to be successful, then re-establishing the PI GCOS is an essential pre-requisite.

P-1105-11
Tipping point analysis of atmospheric oxygen concentration
V. Livina (1) ; V. Teresa (2) ; A. Forbes (1)
(1) National Physical Laboratory, Teddington, United Kingdom;
(2) John Innes Centre, Norwich, United Kingdom

We apply tipping point analysis to nine observational oxygen concentration records around the globe, analyse their dynamics and perform projections under possible future scenarios leading to oxygen deficiency in the atmosphere. This approach is based on stochastic framework with stochastic modelling, where we represent the observed data as a composition of deterministic and stochastic components estimated from the observed data using Bayesian and wavelet techniques.

P-1105-12
OneGeology – A distributed data system that enables access to up-to-date global geoscience data
K. Marko (1) ; D. Tim (2) ; F. Robida (3) ; H. Matt (2) ; A. Lee (4)
(1) OneGeology, Keyworth, United Kingdom; (2) BGS, Keyworth, United Kingdom; (3) BRGM, Orleans, France; (4) Arizona Geological Survey, Tucson, United States of America

OneGeology is an initiative of Geological Survey Organisations (GSO) around the globe that dates back to Brighton, UK in 2007. Since then OneGeology has been a leader in developing geological online map data using a rigorous methodology that encodes semi-scientific geological language known as the ‘GeoSciML’ (currently version 3.2 exists, which enables instant interoperability of the data). Increased use of this new language allows geological data to be shared across the planet by researchers and other organisations. One of very important goals of OneGeology was a transfer of valuable know-how to the developing world, hence shortening the digital learning curve. In autumn 2013 OneGeology was transformed into a Consortium with a clearly defined governance structure, making its structure more official, its operability more flexible and its membership more open where in addition to GSO also to other type of organisations that manage geoscience data can join and contribute. The next stage of the OneGeology initiative will hence be focused into increasing the openness and richness of that data from international countries, a multi-thematic global geological data resource on the rocks beneath our feet. Authoritative information on hazards and minerals will help to prevent natural disasters, explore for resources (water, minerals and energy) and to make early assessment of the potential for climate change and receive health on a planetary scale. With this new stage also renewed OneGeology objectives were defined and these are 1) to be the provider of geosciences data globally, 2) to ensure exchange of knowledge and skills and relevancy of data and 3) to use the global profile of IG T to increase awareness of the geosciences and their relevance among professional and general public. We live in a digital world that enables prompt access to vast amounts of open and human access data. Understanding our world, the geology beneath our feet and environmental challenges related to geology calls for accessibility of geoscience data and OneGeology Portal (portal.onegeology.org) is the place to find them.

P-1105-13
Getting Back to the Source: A review of Earth science data citation and access
M. Parsons (1)
(1) Research Data Alliance, Boulder, France

Creating a great data set is only a life’s work (consider Charles Keeling). Yet, scientists do not receive much recognition for creating rigorous, useful data. At the same time, in a post “climategate” world there is increased scrutiny on science and a greater need than ever to adhere to scientific principles of transparency and reproducibility. In this sense it is clear that scientific assertions must be backed up by precise pointers to the actual evidence used. In many cases this should take the form of a data citation. Indeed the IPCC has increasingly rigorous data citation requirements for its assessment.

The concept of data citation has gained significant traction in recent years. This is most apparent in the Joint Declaration of Data Citation Principles. Some communities such as DataVerse, DataCite, and the Earth Science Information Partners have developed specific guidelines on how to actually cite data. Challenges remain, however, on how to precisely cite specific subsets of very dynamic data. Moreover, there is still some confusion on the purposes of data citation.

This presentation will review the current state of the art in data citation with a special emphasis on new developments coming out of the Research Data Alliance, Force11, and elsewhere. It will make concrete recommendations on the purposes and approaches of data citation, especially in the context of climate research and assessments.

ICOS Atmospheric Thematic Center
L. Rivier, (1) ; L. Hazan (1) ; O. Laurent, (2) ; T. Laurila (3) ; M. Ramonet (4) ; J. Tarniewicz (1) ; C. Yver-Kwok, (2) ; A. Abbaris (1) ; J. Helle, (5) ; C. Garrec (1) ; C. Milcent (1) ; A. Abbaris (1) ; J. Helle, (5) ; C. Philippin (1) ; S. Delealda (1) ; N. Kachroo (1) ; S. Ars (1)
(1) LSCE, Cege/sur-Yvette, France; (2) CSIRO, Clayton, Victoria, Australia; (3) CEA, Gif-sur-Yvette, France; (4) CNRS, Paris, France; (5) FMI, Helsinki, Finland; (4) CNRS and Université de Versailles Saint Quentin, LaSce, Cege/sur-Yvette, France; (5) LSCE, Cege/cnrs/uvsq, Gif-sur–Yvette, France

ICOS is a recently-launched, world-class research infrastructure dedicated to the monitoring and improved understanding of carbon sources and sinks. It consists of a complementary, harmonized networks of long-term monitoring stations focusing on Europe and adjacent regions. ICOS networks will comprise about 40 operational atmospheric stations (measuring atmospheric composition in general parameters, 40 ecosystem stations (measuring fluxes from ecosystems) and about 20 oceanic measurement platforms.

The networks are coordinated through a set of central facilities: three thematic centres respectively for atmospheric, ecosystem and ocean data, and a central analytical lab. The Atmospheric Thematic Center (ATC) has
two main functions:

1. Operate the atmospheric data processing chains, going from data transmission from stations to the routine delivery of quality checked data–stream
2. Carry out regular measurement technology survey, analysis and enable development of new sensors and their testing prior to field deployment in ICOS

The presentation will describe state of the art of atmospheric GHG measurement and data processing with a special focus on quality assurance. It will also present new measurement technique, like isotopic measurement, that can attribute GHG concentration changes to different emission sources.

P-1105-15
Steps toward effective multi-disciplinary research data management systems

D. Schade (1)

(1) National Research Council Canada, Canadian Astronomy Data Centre, Victoria, BC., France

Astronomy is often viewed as a discipline whose data management needs are well taken care of whereas a great many other research disciplines (the "long tail") are struggling without adequate data management systems. Technology and data management practice evolve rapidly and I would argue that no area of research, including astronomy, has any real degree of security for the future. The absence of interoperable, astronomically sound data collections (unlike, say, the medical community, which has a long history of digital data handling and thus has considerable experience and expertise that should be shared with other fields. It is important to acknowledge that astronomy is only one of many disciplines that could collectively share experience with other, less "well-served" communities. It is also important to recognize that we all have much to learn from one another and that interaction with "long tail" research communities will result in better data management practices for astronomy.

Astronomy was part of the "long-tail" or research data 25 years ago. It’s data collections were small, heterogeneous, lacked common standards, and were not interoperable. These properties of astronomy data management have changed dramatically (although we still face many challenges) and they have changed because of the hard work of dedicated cross-disciplinary teams of scientists and technologists. But our field has some demonstrable successes to our credit and has learned some profound lessons.

The central problem in creating multi-disciplinary data management systems is the development of Common Data Models (CDMs), the basis for data collections. That means managing metadata in a way that supports the use cases of the multi-disciplinary research communities. This is true for all fields, including those that address climate change. The reality of astronomy data is that it is still produced in formats that represent thousands of “native data models” from thousands of different instruments. (A “data model”, in our vocabulary, is the structure that carries the meaning of the data and metadata.) The challenge is to develop a data model that supports the transformation of a large set of heterogeneous native data models into a Common Data Model. The Common Data Model (CDM) supports the data management functions (curation, discovery, data access, data security) spanning diverse data collections.

This is the same problem that we face in creating multi-disciplinary data management systems. The process for solving the problem will be very similar. Collect research use cases and define requirements. Identify the metadata elements that are required to satisfy those requirements. Analyse where, in the native data models, those elements can be sourced or which elements can be transformed to produce the needed elements. It is true that we have discussed with researchers representing even fundamental quantities like time and place (astronomy faces the same problem itself) but these can be reconciled.

Two points are worth mentioning with respect to Common Data Models. First, there exists no ideal, complete, and all-encompassing Common Data Model. Second, there is no “lossless” Common Data Model. Compromises are involved and loss of information may take place. A Common Data Model is implemented for the purpose of unifying diverse data collections. At the Canadian Astronomy Data Centre, we endeavored 25 years of creating silos for each data collection by integrating 119 native data models into a single common model. Now there is a single path (shared by all interfaces) to using our data collections. The next step is to move into other research domains by building significant collaborations with other data management communities.

P-1105-16
Current status and strategies of biodiversity data integration in Taiwan

KT. Shao (1)

(1) Biodiversity Research Center, Academia Sinica, Taipei, France

The integration of Taiwan’s biodiversity databases started in 2001, the same year that the Ministry of Science & Technology launched the National Digital Archives Program, the Executive Yuan began the Biodiversity Promotion Plan, and Taiwan joined GBIF as an Associate Participant. Taiwan, hence, embarked on a decade of integrating biodiversity data. Afterward, the “Catalog of Life in Taiwan” (TaiCOL) [57,000+ native species], “Taiwan’s node of GBIF” (TaiBIF) [2.8 M+ georeferenced distributional data], the “Cryobanking and Barcode of Life for Wildlife Genetic Material in Taiwan” (TaiBOL) [3,000 species with 12,000 barcode] and “Taiwan Encyclopedia of Life” (TaiEOL) [18,000+ species pages] are established, integrated and open to public access. The databases aim to promote the collection and integration of national biodiversity data and should be useful for future climate change researches. These databases intimately collaborate with their corresponding global databases of COl, GBIF, BON and P&L, respecting these databases, especially those of ecological distribution generated by different government agencies or NGOs, are nevertheless still dispersed due to assorted reasons. Most people agree that it is imperative to integrate databases, so far, only researchers are unwilling to invest in database building — a kind of academic services — under the current academic evaluation system. The Cross-agency committee of GBIF / Chinese, Taipei was established in Academia Sinica in 2008 to formulate policies on data collection and integration, and the mechanism to make data available to the public. Any commissioned project was hereafter asked to include these policy requirements in the contract. Furthermore, a new project to build the “National Biodiversity Monitoring and Reporting System” (TaiBON) will be initiated soon which will integrate all the long-term biodiversity monitoring and biocitizen data from various agencies in Taiwan as well as collaborate with AP–BON and GÉOD BON.

P-1105-17
Climate change revealed from mass balance of mountain glaciers and polar ice sheets – GLACIOCLIM, the French Glaciers Observatory

D. Six (1) ; C. Vincent (2) ; A. Rabatel (3) ; V. Favier (1) ; P. Wagnon (4)

(1) LGGE – CNRS/UJF, Saint-Martin d’Hères, France; (2) LGGE – CNRS/UJF, Saint-Martin d’Hères, France; (3) UJF, Lgge, Grenoble, France; (4) LTHIE – IRD, Saint Martin d’Hères, France

Mountain glaciers are widely recognized as excellent indicators of climate change over recent centuries (e.g. IPCC, 2013). Glacier mass balance variations are a useful tool to assess climate changes over the 20th and 21st centuries and anticipate future challenges related to water resources and sea level rise.

A multi-level monitoring combining in-situ and remotely-sensed measurements within different climate regions constitutes the strategy recommended by the Global Terrestrial Network for Glaciers (GTN–G) supported by the United Nations Framework Convention on Climate Change (UNFCCC). It should provide the basic data sets required for integrative studies and assessments of the distribution and changes of glaciers and ice caps.

In this context, the French national observatory of glaciers “GLACIOCLIM”, supported by INSU, IRD, IPEV and University of Grenoble in collaboration with local partners, has been developing such a strategy for several decades.
on glaciers in the French Alps, the tropical Andes, the Antarctic and the Himalayas. The policy supported by GLACIOCLIM in terms of data sharing relies on: (1) free access through an interactive database which has been recently redesigned; (2) a contribution to the World Glacier Monitoring System database, so that it improves the World Glacier monitoring System (WGMS) database; and (3) a contribution to the GUMIS initiative for multi-temporal glacier inventories. Our monitoring strategy is based on a comprehensive, consistent set of data, including glaciological measurements (mass-balance, ice, velocity, length and thickness variations), along with hydrological and meteorological measurements. Contrary to the length variations which result from complex ice flow dynamics, mass balance direct indicators are as solid precipitation via accumulation and surface energy fluxes via ablation. Given that most mountainous glaciers are temperate (i.e. close to the pressure melting point), the ice mass flux at the glacier snout during the ablation season serves mainly for melting. Consequently, it is necessary to measure both in summer and winter mass-balance terms over long periods to investigate long-term climate trends. The full network then provides the opportunity to thoroughly analyze the relationships between surface mass balance and meteorological variables on selected glaciers in the world.

Most of the glaciers in the world have been decreasing over the last decades and ice temperature measurements in boreholes at very high altitudes provide a clear evidence of atmosphere induced warming. The key here is to analyze the climate– glacier relationships and to provide the cause of this decrease in selected mountainous regions (Himalaya, Andes and Alps) based on glaciological measurements remote-sensing data and results from simple to complex models. The surprising paradox of East Antarctica, where surface mass balance changes are still limited will also be justified in view of data from the GLACIOCLIM observatory.

P-1105-18
Observing Climate Variability and Change with GPS Radio Occultation

AK. Steiner (1); B. Scherllin-Pirscher (1); F. Ladstädter (1); L. Brunner (1); M. Schwärz (1); R. Blondi (1); J. Fritzer (1); J. Schwarz (1); U. Foelsche (2); G. Kirchengast (1)
(1) Wegener Center for Climate and Global Change, University of Graz, Graz, Austria; (2) Institute for Geophysics, Astrophysics, and Meteorology/Institute of Physics, University of Graz, Graz, Austria

Overall agreement on global warming of the troposphere and cooling of the stratosphere exists from conventional observations. However, uncertainty in trend rates and their vertical distribution limits the availability and consistency of future climate models for climate scenarios. Thus, the use of high-resolution data sets is essential for performing a reliable climate assessment of the future. Outputs from the Coupled Model Intercomparison Project 5 (CMIP5) are ideal platforms to record vertical profiles from ground to 12 km to the tropopause region over areas never or poorly sampled by other programs (e.g. surface or sounding networks) and to sample the atmosphere poorly sampled by other programs (e.g. surface or radio sounding networks) and to sample the atmosphere.

Radio Occultation (RO) observations based on Global Positioning System (GPS) signals make up an important part of the global network of RO. The traceability to fundamental time standards with precise atomic clocks assures a long-term stable and consistent record with global coverage and all-weather utility. RO data from the IAGOS (In-Service Aircraft – Current Achievements) project, a reduced set of automatic instruments) and (ii) iaGOs-fr/mozaic) and CariBiC (Civil aircraft for the regular monitoring, numerical weather prediction, and satellite products. Since its participation in the on-going MACC projects (http://www.iagos.fr/macc), and demonstration

P-1105-19
Global-Scale Atmosphere Monitoring by In-Service Aircraft – Current Achievements and Future Prospects of the European Research Infrastructure IAGOS

V. Thouret (1); A. Petzold (2); C. Brenninkmeijer (3); J.P. Cammas (4); P. Dandin (5); J. Maide (6); M. Gallagher (7); C. Gerbig (8); M. Hermann (9); P. Nedelec (1); M. Pontaud (1); S. Smit (2); A. Vollmers (10); A. Wahner (11); A. Zahn (12); H. Ziereis (13)
(1) CNRS et Université Paul Sabatier – Observatoire Midi-Pyrénées, Toulouse, France; (2) Forschungszentrum Jülich GmbH, Institute of energy and climate research 8 – troposphere, Jülich, Germany; (3) Max Planck Institute for Chemistry, Mainz, Germany; (4) CNRS et Université Paul Sabatier – Observatoire Midi-Pyrénées, Toulouse, France; (6) CNRS, Paris, France; (7) University of Manchester, Manchester, United Kingdom; (8) Max Planck Institute for Biogeochemistry, Jena, Germany; (9) Leibniz Institute for Tropospheric Research, Leipzig, Germany; (10) IAGOS-AISBL, Brussels, Belgium; (11) Forschungszentrum Jülich GmbH, Institute of energy and climate research 8 – troposphere, Jülich, Germany; (12) Karlsruhe Institute of Technology, Karlsruhe, Germany; (13) DLR Institute of Atmospheric Physics, Oberpfaffenhofen, Germany

Reliable predictions of the future climate using climate models are central and fundamental requirements for determining future mitigation strategies. The use of commercial aircraft allows the collection of highly relevant observations on a global scale. Through the establishment of IAGOS, which is achieved using research aircraft, and at altitudes where other measurement methods (e.g., satellites) fail. It has been extensively demonstrated by 3 ongoing international projects in Europe and Japan now that commercial aircraft are ideal platforms to record vertical profiles from ground to 12 km to the tropopause region over areas never or poorly sampled by other programs (e.g. surface or radio sounding networks) and to sample the atmosphere poorly sampled by other programs (e.g. surface or radio sounding networks) and to sample the atmosphere.
and delivery of core data in near real time (NRT) and soon in real time for a subset of information. IAGOS is considered a major contributor to the in-situ component of Copernicus Atmosphere Monitoring Services (CAMS). The IAGOS infrastructure is currently the only approach to providing regular in-situ observations in the UT/LS over mid-latitudes at high spatial resolution (4 seconds or 1 km horizontally) and vertical profiles (4 seconds or 30 meters vertically) of reactive gases, greenhouse gases, and aerosol concentrations in the troposphere over continental sites, never or sparsely sampled by other programs, (e.g., in Africa, South East Asia, and South America). In combination with its predecessor programs MOZAIC and CARIBIC, IAGOS has been providing observational data of atmospheric chemical composition in the UT/LS since 1994 with to date 20 year time series of temperature, H2O and O3, and 9–15 years of aerosol, CO, NOy, CO2, CH4, N2O, SF6, Hg, acetone, ~30 HFCs, ~20 NMHC data. This presentation will give an overview of the original results achieved so far and a number of highlights to illustrate the promise IAGOS data hold for the community of users. One of the most striking examples we will highlight concerns evaluation of forecast runs with IAGOS NRT data as proposed in the frame of CAMS.

A uniform metadata exchange standard is designed for WDS members in China. In order to advance the data and metadata services quality, an integrated data and metadata update mechanism are proposed based on the review and training mechanism supported by WDS China secretory office. Finally, a new clearing house portal is provided which can be accessed by WDS portal directly.

**P-1105-21**

**60-year Database of Cosmic-Ray Neutron Fluxes held by the WDC for Cosmic Rays**

T. Watanabe (1)

(1) National Institute of Information and Communications Technology, Integrated Science Data System Research Laboratory, Koganei, Tokyo, Japan

It has been suggested by a number of authors that fluctuations in the cosmic-ray, which are known to be caused by changes in interplanetary magnetic fields, can be recognized in this several solar cycles, reflecting a weakening tendency of the solar activity. Although a weak inverse correlation is seen between the solar activity and the global temperature in 1953-2006, the correlation analysis is strongly affected by the global cooling presumably caused by two major volcanic eruptions (El Chichon in 1982, and Pinatubo in 1991). Both eruptions were “accidentally” taken place in two subsequent solar-cycle maxima.

http://center.stelab.nagoya-u.ac.jp/WDCCR/.

---

**K-1106-01**

**Earth’s energy imbalance: current knowledge and future challenges**

M. Palmer (1)

(1) Met Office, Hadley Centre, Exeter, United Kingdom

Anthropogenic climate change arises from the accumulation of excess solar energy in the earth system through increases in heat-trapping greenhouse gases associated with human activities. The various aspects of anthropogenic climate change (surface temperature rise, increased rainfall rates, loss of glaciers, global sea level rise, changes in climatic extremes) are all symptoms of this accumulation of energy, of which > 90% is manifested in the energy imbalance (EEI) at the earth system. EEI is defined by Earth’s energy imbalance (EEI) and this represents the most fundamental quantity for monitoring ongoing global warming.

Ultimately, the impacts of climate change will be determined by the future evolution of EEI and how this additional energy interacts with the flows of energy within the Earth system. Measured compounds along the Earth system serve as key biogeochemical–physical interactions and feedbacks between the ocean and atmosphere, and how this coupled
System affects and is affected by global change. Our understanding of when changing the marine, gaseous, and particles at the atmosphere–ocean interface has advanced over the past decade but there are still large uncertainties to adequately parameterize fundamental controlling processes as identified in the new research strategies of the international SOLAS group (Law et al., 2013). In this context, the scientific questions driving SOLAS research are highly challenging, inherently multidisciplinary, and broad in scope in both space and time. (i) How is the atmospheric exchange of climate–relevant gases and particles? (2) How does the atmospheric deposition of material impact ocean biogeochemistry? (3) What are the links between the ocean, atmosphere, aerosols, and clouds? (4) What are the biogeochemicals responsible for emissions of highly reactive gases that impact atmospheric photochemistry and stratospheric ozone?

Climate mitigation policies based on greenhouse gas budgets must take into account the role of ocean–atmosphere fluxes for future projections. In that context, several of the eogenoengineering schemes currently debated for climate mitigation are directly linked to the atmosphere–ocean system, including ocean iron fertilization, sea spray generators, ocean foams, and modification of the ocean upwelling. Informed assessment of their feasibility, efficacy and potentially unintended effects will derive from SOLAS science.

This presentation will overview the SOLAS 2004–2014 goals and main accomplishments and present the SOLAS 2015–2025 rationale and scientific scope.

O-1106-01

Origin of the Recent Tropical Atlantic SST warming: the role of ocean dynamics

J. Servain, (1) ; G. Caniaux (2) ; A. Hounou-Gbo (3) ; Y. Koudia (4) ; M. McPhaden (5) ; M. Araujo (3)

(1) RAS Institute for Oceanology, SAIL, Moscow, Russia; (2) CNRM/GAME (Météo-France/CNRS), Toulouse, France; (3) Universidade de Pernambuco, Departamento de oceanografia, Recife, Brazil; (4) University Felix Houphouet Boigny - Cocody de Pernambouco, Departamento de oceanografia, Recife, Brazil; (5) NOAA, Seattle, United States of America

During the last decades, the sea surface temperature (SSTs) of the whole tropical Atlantic has substantially increased. Since the 1960s, the mean SST series of the tropical Atlantic [30°N–20°S, 60°W–15°E] has gained some 0.6°C. Moreover, the SSTs of the north-western part of the basin with values up to 1°C, as well as the coastal upwelling regions off the African coast, have increased since the 1990s, at a rate of 0.25°C per decade for the whole basin. When regionalized, the most severe warming affects the north-western part of the basin with values up to 1°C, as well as the coastal upwelling regions off the African coast. Surprisingly, the trade wind system, that drives the equatorial upwellings, strengthened since the 1960s and specially since the 1980s. These changes have been established by considering various independent observational data sets, allowing to prove the robustness of the results.

The origin of the SST change has been investigated by analyzing the changes of the air–sea surface fluxes and of the water column by considering integral quantities like sea surface salinity and upper level heat contents. It appears that the SST warming is not directly related to the local surface heat fluxes, which tend to increase the ocean heat loss. This implies that the signal is not coming from the atmosphere but rather from the ocean itself, i.e. due to recent changes in the ocean dynamics. Moreover, lagged correlation patterns between heat content and SSTs, suggest the existence of a relationship between the SST warming and the circulation in the northern tropical Atlantic. Finally, several hypotheses are presented to conciliate both the strengthening of the wind–stress, the SST and upper–water warming, as well as the break point dates that reflect the trend.

O-1106-02

Oceanic biotic components, production mechanism of organic aerosol in Marine Boundary Layer ans cloud–climate system

M. Facchinetti (1) ; C.D. O’dowd (2) ; R. Danovaro (3)

(1) National Research Council (CNR), Institute of Atmospheric Sciences and Climate (ISAC), Bologna, Italy; (2) National University of Ireland Galway, School of Physics and Centre for climate & air pollution studies, ryan institute, Galway, Ireland; (3) Polytechnic University of Marche, Department of life and environmental sciences, Ancona, Italy

Studies performed during the past years strongly suggest that biogenic organic compounds play an important role in submicron marine aerosol chemical composition over biologically productive, high latitude, marine regions, in both hemispheres and new biogenic oceanic sources of primary and secondary origin of OA were revealed. We discuss on the global importance of biogenic OA marine sources and their high spatial and temporal variability and the complex interaction with gaseous biogenic precursors and oceanic biotic components (Phytoplankton, viruses and bacteria). Submicron marine organic aerosol are a complex mixture of biogenic materials transferred from the ocean surface by the sea spray or by oxidative gas to particle conversion of volatile organics emitted by decomposition processes of oceanic dissolved organic carbon. The role of marine biota on the evolution of plankton bloom and on the partitioning of organic carbon in POC and DOM reservoirs and transfer mechanisms into MBL will be discussed.

P-1106-01

Comparative assessment of surface fluxes from different sources: a framework based on probability distributions

S. Gulev (1)

(1) RAS Institute for Oceanology, SAIL, Moscow, Russia

Surface turbulent heat fluxes from modern era and first generation reanalyses (NCEP-DOE, ERA-Interim, MERRA, NCEP-CSFR, JRA) as well as from satellite products (SEAFLUX, IFREMER, HOAPS) were intercompared using framework of probability distributions for sensible and latent heat fluxes. For approximation of probability distributions and estimation of extreme flux values Modified Fisher–Tippett (MFT) distribution has been used. Besides mean flux values, consideration is given to the comparative analysis of (i) parameters of the MFT probability density functions (scale and location), (ii) extreme flux values corresponding high order percentiles of fluxes (e.g. 99th and higher) and (iii) fractional contribution of extreme surface flux events in the total surface turbulent fluxes integrated over months and seasons. The latter was estimated using both fractional distribution derived from MFT and empirical estimates based upon occurrence histograms. The strongest differences in the parameters of probability distributions of surface fluxes and extreme surface flux values between different reanalyses are found in the western boundary current extension regions and high latitudes, while the highest differences in the fractional contributions of surface fluxes may occur in mid ocean regions being closely associated with atmospheric synoptic dynamics. Generally, satellite surface flux products demonstrate relatively stronger extreme fluxes compared to reanalyses, even in the Northern Hemisphere midlatitudes where data assimilation input in reanalyses is quite dense compared to the Southern Ocean regions. Our assessment also discussed the differences between satellite and satellite products with respect to their ability to quantify the role of extreme surface turbulent fluxes in forming ocean heat release in different regions.

P-1106-02

The New Planetary Energetic Budget, the New Climate and the New Water Cycle in the North Atlantic Ocean and its edges

M.S. Karrouk (1)

(1) University Hassan II, Climatology Research Centre (CERC), Geography, Climatology, Casablanca, Morocco

Global warming has now reached the energetic phase of H2O return to the atmosphere and the atmosphere in evaporation since the 80s and 90s of the last century, which were characterized by severe droughts, mainly in Africa.
This phase is the result of the accumulation of thermal energy exchanges in the Earth–Ocean–Atmosphere system that resulted in the thrust reversal of the energy balance toward the poles. This situation is characterized by a new thermal distribution: above the ocean, the situation is more in surplus compared to the mainland, or even opposite when the balance is negative on the land, and in the atmosphere, warm thermal advection easily reach the North Pole (planetary crests), as well as cold advection push deep into North Africa and the Gulf of Mexico (planetary valleys).

This «New Ground Energy Balance» establishes a «New Meridian Atmospheric Circulation (MAC)» with an undulating character throughout the year, including the winter characterized by intense latitudinal very active energy exchanges between the surplus areas (tropical) and the deficit (polar) on the one hand, and the atmosphere, the ocean and the continent on the other.

The excess radiation balance increases the potential evaporation of the atmosphere and provides a new geographical distribution of H2O worldwide: the excess water vapor is easily converted by cold advection (polar vortex) to heavy rains that cause floods or snow storms that paralyze the normal functioning of human activities, which creates many difficulties for users and leaves damage and casualties, but ensures water availability meaning since a long time in many parts of the world, in Africa, Europe and America.

The new thermal distribution reorganizes the geography of atmospheric pressure: the ocean energy concentration is transmitted directly to the atmosphere, and the excess torque is pushed northward. The Azores anticyclone is strengthened and is a global lock by the Atlantic ridge at Greenland, which imposes on the jet stream a positive ripple, very strongly marked poleward, bringing cosmic cold advection of polar air masses winter over from Europe to North Africa. Hence the enormous meridian heat exchanges north–south, and south–north.

This new spatial thermal provision therefore imposes on the jet-stream a positive ripple on the North Atlantic (Greenland) and eastern Pacific (Alaska); this is the cause of the heat and drought of California, followed by negative waves in eastern US, and Europe.

This is the «New Atmospheric Circulation» predominantly «Meridian», due to the «New Climate» caused by global warming.

**P-1106-03**

**Changes in global energy imbalance at the top of the atmosphere and surface 1985-2014**

CL. Liu (1); R. Allan (1); N. Loeb (2); M. Palmer (3); D. Smith (3); P. Hyder (3)

(1) Department of Meteorology, University of Reading, Reading, United Kingdom; (2) NASA Langley Research Centre, Hampton, United States of America; (3) Met Office, Hadley Centre, Exeter, United Kingdom

Combining satellite data, atmospheric reanalyses and climate model simulations, variability in the net downward radiative flux imbalance at the top of Earth’s atmosphere (N) are reconstructed and linked to recent climate change. Over the period 1985–2012 we estimate N=0.47±0.54 Wm−2 (uncertainties at 90% confidence level). Variability relates primarily to the eruption of Mt. Pinatubo in 1991 and El Niño Southern Oscillation with good agreement (r=0.6) between the monthly reconstruction and atmospheric simulations using prescribed sea surface temperature and radiative forcings. Combining with a simple energy balance climate model we argue that increased ocean heat uptake below the mixed layer is required to reconcile changes in N and surface temperature since 1985.

The surface net fluxes can be estimated based upon the reconstructed N and the atmospheric energy tendencies and transports from the ERA–Interim reanalysis. The energy divergences over the oceans are adjusted to remove an unphysical residual global mean atmospheric energy divergence. The estimated net surface energy fluxes are compared with reanalysis and atmospheric model simulations. The spatial correlation coefficients of multi–annual means between the estimations made here and other data sets are all around 0.9. There are good agreements in area mean anomaly variability over the global ocean. The interannual differences and precipitation biases are also discussed.

**P-1106-04**

**Uncoupling the ocean and sea-ice from the atmosphere: Challenges of Coordinated Ocean-ice Reference Experiments (COREs)**

AM. Treguier (1); G. Danabasoglu (2); S. Marsland (3); S. Griffies (4); W. Omdp Members (5)

(1) CNRS, LPO, IUERM, Plouzane, France; (2) NCAR, Boulder, United States of America; (3) CSIRO, Melbourne, Australia; (4) NOAA – GFDL, Princeton, United States of America; (5) CLIVAR ICGPO, State oceanographic administration first institute of oceanography, Qingdao, China

Earth system models are complex, and the interactions and nonlinear feedbacks between their different components are poorly understood. Climate predictions benefit from an independent validation of each component of the model, before coupling them together. Atmospheric Model Intercomparison Projects, which involve forcing the atmospheric models with observed sea surface temperatures (SST) and sea–ice cover, have existed since the early days of IPCC. In contrast, a similar exercise for ocean–sea–ice models has been difficult to implement, because there are long time scale interactions between the ocean–ice–atmosphere system, and there are large uncertainties in observations within the atmospheric boundary layer.

Under the umbrella of the World Climate Research Program’s (WCRP) Climate and Ocean Variability, Predictability and Change (CLIVAR) Project, the Ocean Model Development Panel (OMDP) has worked for over a decade to develop a meaningful validation of ocean–sea–ice models for our present climatc and has produced a common protocol: Coordinated Ocean–ice Reference Experiments (COREs). CORE consists of running ocean–sea–ice coupled models with a fixed atmospheric state (observed air temperature, humidity, boundary layer winds, downward radiation, precipitation, and river runoff). This atmospheric state has been obtained in such a way to produce realistic globally averaged heat and freshwater fluxes when combined with observed SST. Existing atmospheric reanalysis products such as NCEP or ERA are not yet suitable for this purpose without corrections. Prescribing the air temperature, rather than heat flux, is necessary in order to allow the feedbacks between the evolving SSTs and the air–sea heat fluxes: this feedback is essential to ensure the stability of the ocean–ice system.

The main challenge in the CORE framework stems from the lack of sufficient feedbacks in the water cycle. If evaporation increases over the ocean, the extra water is likely to return to the ocean as rain or runoff on long time scales. Because this nonlocal feedback is neglected when the atmospheric state is fixed, it has been necessary to introduce an arbitrary relaxation of the surface salinity to observations. In part due to this salinity forcing, CORE simulations subject to the same atmospheric state exhibit very different large scale ocean circulations: this finding underlines our limited capacity to fully validate the ocean–sea–ice components of earth system models used for climate scenarios, independently of the atmosphere. Nevertheless, a recent suite of CORE experiments carried out with over 20 different models brings new insights into the reproducibility and robustness of essential climate variables such as regional sea level patterns and the North Atlantic overturning circulation.
Measuring Earth’s polar ice sheets from space

A. Shepherd (1) ; E. Ivins, (2)
(1) University of Leeds, School of earth and environment, Leeds, United Kingdom; (2) Caltech, Pasadena, United States of America

Earth’s ice responds rapidly to climate forcing, and satellite observations have become an essential tool with which to measure and understand these changes. Although considerable progress has been made in quantifying recent fluctuations in ice sheet mass balance, significant challenges remain in attempting to predict future ice sheet losses. This is because past changes have been too small to reliably judge the performance of the ice sheet models upon which predictions are currently based. In consequence, there is a continued need for satellite-based observations of the polar ice sheets. The project brings together the laboratories and space agencies of the contribution due to external signals. The project outline progress towards a second ice sheet mass balance inter-comparison exercise. The Ice Sheet Mass Balance Inter-Comparison Exercise (IMBIE) was established in 2011 as a joint initiative of the European Space Agency (ESA) and the US National Aeronautics and Space Administration (NASA) as an attempt to resolve the apparent disagreement between geodetic estimates of ice sheet mass balance. Within IMBIE, estimates of ice sheet mass balance are developed from all three geodetic techniques using a common spatial and temporal reference frame and a common appreciation of the contributions due to external signals. The project brings together the laboratories and space agencies that have been instrumental in developing independent estimates of ice sheet mass balance to date.

In 2012, the first IMBIE assessment was delivered. It included 19-years of satellite radar altimeter data, 5-years of satellite laser altimeter data, 18-years of satellite radar interferometer data, 7-years of satellite gravimetry data, 32-years of surface mass balance model predictions, and precipitation climatology as a check of the model performance. Since then, further changes have occurred in Antarctica and Greenland, and the record of satellite observations has been extended through continued operation of existing missions, such as GRACE, and through the availability of measurements from new sensors, including CryoSat-2 and Sentinel-1a.

This presentation will review the latest satellite measurements of Antarctica and Greenland, and will outline progress towards a second ice sheet mass balance inter-comparison exercise.

Present-day sea level rise

A. Cazenave (1)
(1) CNES, LEGOS, Toulouse, France

We review most recent progress realized in measuring global mean sea level (GMSL) over recent decades and satellite altimetry era (starting in 1993), as well as in understanding the causes of the observed rise (i.e., ocean thermal expansion, land ice loss and terrestrial water storage changes). The IPCC 5th Assessment Report revisited the sea level budget for the last few decades and came to rather good agreement between observed GMSL and sum of climate and non-climate contributions. Over the satellite altimetry era, GMSL rise (of 3.2 mm/yr) is reasonably well explained by ocean thermal expansion (contributing ~37%) and land ice loss from glaciers and ice sheets (contributing together ~15%). Terrestrial water storage change (mostly due to ground water pumping) is supposed to explain the remaining, but this component is quite uncertain. For about 10 years, new observing systems from space and in situ (e.g., GRACE space gravimetry, Argo profiling floats) allow improved estimates of the various contributions to sea level rise, in particular direct estimate of ocean mass change. These observations indicate that over 2005-2013, ocean thermal expansion rose less rapidly than during the 1990s (with a contribution of only 28%) while the ocean mass increase now explains ~66% of the GMSL rise. This mostly results from ice mass loss acceleration from the ice sheets. This improved sea level budget approach allows us to put constraints on the contribution of the deep ocean (not seen by Argo) and its role in the current ‘hiatus’.

Projections of sea level change

J. Gregory (1)
(1) NCAS, University of Reading and Met Office Hadley Centre, Reading, United Kingdom

It is very likely that the rate of global mean sea level rise (GMSLR) during the 21st century will exceed the rate during 1971-2010, due to increases in ocean warming and loss of mass from glaciers and ice sheets. Ocean thermal expansion is the largest contributor to projections of GMSLR during the 21st century. For a given scenario, there is a substantial spread in climate model projections of thermal expansion, and in the geographical pattern of sea level change due to ocean density and circulation change. Larger uncertainty in projections of GMSLR comes from the land-ice contributions, especially ice-sheet dynamical change. These contributions also influence regional sea-level change, through their effect on gravity and the solid Earth. GMSLR by 2100 is likely to be in the range 0.28–0.61 m above the 1986–2005 mean under a scenario of strong mitigation (RCP2.6), and 0.52–0.98 m under a scenario of high emissions (RCP8.5). Unlike surface temperature change, GMSLR depends on the pathway of CO2 emissions, not only on the total; earlier emissions of the same total lead to greater GMSLR. By the end of the century, the rate of GMSLR under RCP2.6 could stabilise at rates similar to those of the early 21st century, while under RCP8.5 it could approach the average rates that occurred during the last deglaciation. It is very likely that regional sea level rise will be positive over about 95% of the world ocean, and about 70% of the global coastlines are projected to experience a relative sea level change within 20% of the global mean. Based on current understanding, only the collapse of marine-based sectors of the Antarctic ice sheet, if initiated, could cause GMSLR above the likely ranges during this century, but GMSLR
will continue for many subsequent centuries, because of the ongoing ice–sea–ground and deep-ocean warming, and could be partly irreversible.

**1107—POSTER PRESENTATIONS**

P-1107-01

Two Decades of Global and Regional Sea Level Observations from the ESA Climate Change Initiative Sea Level Project

M. Ablain, (1) ; JF. Legeais (2) ; A. Cazenave (3) ; B. Meyssignac (4) ; G. Larnicol, (1) ; J. Benveniste, (5)

(1) CLS, DOS, PMC, Ramonville St Agne, France; (2) CLS, Space Oceanography Division, Ramonville St Agne, France; (3) CNRS–CNES, Laboratoire d'études en géophysique et océanographie spatiales, Toulouse, France; (4) CNES, Legos, Toulouse, France; (5) ESA, Estin, Frascati, Italy

Sea level is a very sensitive index of climate change and variability. Sea level integrates the ocean warming, mountain glaciers and ice sheet melting. Understanding the sea level variability and changes implies an accurate monitoring of the sea level variable at climate scales, in addition to understanding the ocean variability and the exchanges between ocean, land, cryosphere, and atmosphere: That is why Sea Level is one of the Essential Climate Variables (ECV) selected in the frame of the ESA Climate Change Change Initiative (CCI) program. It aims at providing long-term monitoring of the sea level ECV with results useful as required for climate change studies. After a first phase (2011–2013), the program has started in 2014 a second phase of 3 years. The objectives of this second phase are to involve the whole research community, to refine their needs and collect their feedbacks on product quality, to develop and select the best algorithms and standards to generate an updated climate time series and to produce and validate the Sea Level ECV product. This will better answer the climate user needs by improving the quality of the Sea Level products and maintain a sustain service for an up-to-date production. To this extent, the CCI time series has been extended and it now covers the period 1993–2013.

We will firstly present the main achievements of the ESA CCI Sea Level Project. On the one hand, the major steps required to produce the 21 years climate time series are briefly described: collect and refine the user requirements, development of adapted algorithms for climate applications and specification of the production system. On the other hand, the product characteristics are described as well as the results from product validation, performed by several groups of the ocean and climate modeling community. At last, the work plan and key challenges of the second phase of the project are described.

P-1107-02

Error characterization of global Mean Sea Level time series deduced from TOPEX, Jason-1 and Jason-2 altimeter missions

M. Ablain, (1) ; L. Zawadzki, (1) ; P. Prandi, (1)

(1) CLS, DOS, PMC, Ramonville St Agne, France

With the satellite altimetry missions, the global mean sea level (GMSL) has been calculated on a continual basis since January 1993. ‘Verification’ phases, during which the satellites follow each other in close succession (TOPEX/Posidon-Jason-1, then Jason-1—Jason-2), help to link up these different missions by precisely determining any bias between them. The global mean sea level (MSL) deduced from these 3 altimetric missions provides a global rate of 3.2 mm from 1992 to 2013, applying the post glacial rebound (MSL AVISO website http://www.jason.oceanobs.com/msl).

Within the ESA Climate Change Initiative program, the users requirements have been collected and for the users of the Sea Level ECV, it is crucial to know as much as possible the errors impacting the MSL calculation in order to analyze the MSL variability. In this paper, we propose to describe in details the approach developed to compute this confidence envelop. We will also present the results obtained and how to interpret them.

P-1107-03

Altimeter sea level rise assessment with tide gauge measurements

M. Ablain, (1) ; P. Prandi, (1) ; G. Valladeau, (1)

(1) CLS, DOS, PMC, Ramonville St Agne, France

Since the first altimeter missions and the improvements performed in the accuracy of sea surface height measurements from 1992 onwards, the importance of global quality assessment of altimeter data has been increasing. Global CalVal studies usually assess this performance by the analysis of internal consistency and cross-comparison between all missions. The overall quality assessment of altimeter data can be performed by analyzing their internal consistency and the cross-comparison between all missions.

As a complementary approach, tide gauge measurements are used as an external and independent reference to enable further quality assessment of the altimeter sea level data and provide a better estimate of the multiple altimeter performances. In this way, both altimeter and tide gauge observations, dedicated to climate applications, require a quality control. The tide gauge time series considered in this study derive from several networks (GLOSS/CLIVAR, PSMSL, REFMAR) and provide sea-level heights with a physical content comparable with altimetry sea level estimates.

Concerning altimeter data, the long-term drift assessment can be evaluated thanks to a widespread network of tide gauges. Thus, the comparison between in-situ measurements and altimetry sea level for the main altimeter missions. If altimeter time series are long enough, tide gauge data provide a relevant estimation of the global Mean Sea Level (MSL) drift calculated for all the missions. Moreover, comparisons with sea level products merging all the altimeter missions together have also been performed using several datasets, among which the AVISO delayed-time Sea Level Anomaly grids.

P-1107-04

Probabilistic surface reconstruction of coastal sea level rise during the twentieth century

G. Choblet (1) ; H. Laurent (2) ; T. Bodin (3)

(1) CNRS – Université de Nantes, Laboratoire de Planétologie et Géodynamique, Nantes, France; (2) CNRS – Université Joseph Fourier, Isterre, Grenoble, France; (3) UC Berkeley, Earth and planetary science, Berkeley, United States of America

We present a new surface reconstruction procedure based on the Bayesian inference methodology for coastal relative sea level variation during the twentieth century. Average rates are computed from tide gauge records. Models based on a Voronoi tessellation adapt to the level of information which proves well suited to the strong heterogeneity of data. Each point of the reconstructed surface is defined through a probability density function, a format particularly well adapted to this climate-related datum. The resolution of reconstructed surfaces strongly varies among the six large regions considered and within a given region. Anomalalous sea level variations recorded locally are shown to reflect either anthropogenic effects or well-identified fast tectonics. For a poor data coverage, these can cause a problematic distortion of the reconstructed surface. Europe, North America, Australia, and Africa present a single trend with a decreasing precision of the reconstructed surface. In the Americas, resolution of the tide gauge record. The most prominent feature in Europe is the pronounced uplift of Fennoscandia. Coasts of United States have the best resolution in North America and present stronger rates of sea level rise on the Atlantic than their European counterparts. Australia (especially in
ABSTRACT BOOK

P-1107-05

Climatic information from unexplored areas of East Antarctica: The French ITASE Contribution

V. Favier (1); L. Arnaud (1); G. Delaygue (1); M. Fily (1); H. Gallée (1); C. Genthon (1); B. Jourdain (1); G. Krinner (1); A. Landais (2); M. Legrand (1); M. E. Le (1); G. Magand (1); V. Masson-Delmotte (2); B. Minster (2); G. Picard (1); S. Preunkert (1); F. Pré (2); F. Remy (3); J. Savarino (1)
(1) LGGE, Grenoble, France; (2) LSCE, Gif-sur-Yvette, France; (3) LEGOS, Toulouse, France

Antarctica is the largest ice reservoir on Earth. In the context of climate change, the surface mass balance (SMB) of Antarctica will play a major role in the evolution of sea level. Knowledge of the current variations of Antarctic SMB is thus a major challenge. However, for Antarctica the spatially averaged SMB is still poorly constrained because field data are sparse. The IPCC fifth assessment report (ARS) has highlighted this uncertainty as one of the main scientific challenges in climate science.

How the surface mass balance of Antarctica will change in the future?

In spite of decades of studies, an international effort is still necessary to reduce the important remaining uncertainties. Especially, large regions of Antarctica are still unexplored. Hence, scientific traverses have been designed in the framework of SCAR–ITASE program (International Trans-Antarctic Scientific Expeditions) to collect invaluable samples and observations in the field. In the context of ITASE project, the French glaciology community has launched a program to get new information on surface mass balance. During the 2009–10, 2011–2012 and 2013–2014 scientific traverses have been performed over large distances on the Antarctic plateau. However, the coast-to-plateau transition zone has been largely unexplored, whereas this is where most of future changes are expected to occur. Hence, a new traverse is planned in this area for the summer 2016–17. Using up-to-date techniques, we propose to collect information on snow physical properties to analyze the processes responsible for their spatial and temporal variations. A special attention will be paid on the way to use remote sensing data to infer the physical characteristics of snow. This knowledge is expected to allow us to interpret remote sensing signal in terms of surface mass balance changes. Getting information on how the origin and transport of moisture affect chemical and isotopic signals stored in firn and ice will also be a priority. This knowledge will help us to validate model simulations and to improve our understanding of Antarctic SMB. Data obtained during this new traverse will be used to forecast future surface mass balance changes.

The goal of this presentation is to describe recent results obtained by the French ITASE community, and to describe its strategy for future research performed in Antarctica.

P-1107-06

Testing the sensitivity of the East Antarctic Ice Sheet to Southern Ocean dynamics: past changes and future implications

C. Fogwill (1); C. Turney (1); K. Meissner (1); N. Golledge (2); P. Spence (1); J. Roberts (3); M. England (4); R. Jones (5); L. Carter (2)
(1) University of New South Wales, Climate Change Research Centre, Sydney, NSW, Australia; (2) Victoria University of Wellington, Antarctic research centre, Wellington, New Zealand; (3) Australian Antarctic Division, Institute of marine and atmospheric studies, Hobart, Australia; (4) The University of New South Wales, Climate change research centre, Sydney, Australia; (5) University of Exeter, Geography, Exeter, United Kingdom

The stability of Antarctic ice sheets and their potential contribution to sea level under projected future warming remains highly uncertain. The Last Interglacial (135,000–116,000 years ago) provides a potential analogue, with global temperatures 2°C higher and rates of sea-level rise >5 mm ka−1, leading to sea levels 6.6–9.4 m higher than present. The source(s) of this sea–level rise remain fiercely debated.

Here we report a series of independent model simulations exploring the effects of migrating Southern Hemisphere Westerlies (SHWs) on Southern Ocean circulation and Antarctic ice-sheet dynamics. We suggest that southerly shifts in winds may have significantly impacted the subpolar gyres, inducing pervasive warming (0.2–0.8°C in the upper 1,200 m) adjacent to sectors of the East Antarctic Ice Sheet (EAIS), which can be associated with ice loss. When control to interglacial sea levels, and given 21st-century projections in the Southern Annular Mode and associated SHW migration, we highlight how pervasive circum-Antarctic warming may threaten EAIS stability.

P-1107-07

Uncertainties on the surface mass balance of Antarctica

C. Genthon (1); C. Palerme (1); H. Barral (2); C. Amory (2)
(1) CNRS, Laboratoire de Glaciologie et Géophysique de l’Environnement, Saint Martin d’Hères, France; (2) Université de Grenoble Alpes, Laboratoire de glaciologie et géophysique de l’environnement, Saint Martin d’Hères, France

On average, the ~12 106 km³ of the grounded Antarctic ice sheet accumulates ~15 cm of water equivalent per year at its surface. The major term in the surface mass balance equation is precipitation, mainly in the form of snowfall. Other terms include evaporation/frost deposition, melting and runoff to the oceans, and blowing snow effects. Climate models may be constrained by forcing if they do with varying degrees of realism which can only be evaluated against past or present day observations. All climate models simulate precipitation and predict an increase of Antarctic snowfall but disagree on the magnitude of the increase. A 20 % increase (everything else unchanged) would induce a ~1 mm/year moderation of sea-level rise due to other causes of sea–level change. Unfortunately, there are no in situ observations of Antarctic snowfall that can be used to confidently assess model performance and sort out their reliability. Satellite data suggest that most models overestimate Antarctic precipitation. Those models closest to the satellite data predict a larger precipitation increase and impact on sea–level. Blowing snow is a frequent phenomenon on the peripheral slopes of the Antarctic ice sheet where catabatic winds blow, but none of the past IPCC climate models have accounted for this process and a possible contribution to surface mass balance change. There are few observations of Antarctic blowing snow and those available suggest systematic model biases in blowing snow conditions. Although the current mean surface mass balance of Antarctica is relatively well known from glaciological measurements, there is a deficit of evaluation and validation of the independent components of and thus of the physical processes which may be individually and differently altered in a changing climate.

P-1107-08

Avoided Sea Level Rise from thermal expansion for RCP4.5 versus RCP8.5

A. Hu (1); S. Bates, (1)
(1) National Center for Atmospheric Research, Boulder, CO, United States of America

Observational evidence shows that as the global mean temperature increases, the global mean sea level is also rising. The rising sea level could impose significant impacts on coastal communities, especially when this rising sea is compounded with storm surges. Here, by analyzing
Analyses of altimetry errors using Argo and GRACE data
JF. Legeais (1) ; P. Prandi, (2) ; M. Ablain, (2) ; N. Picot (3)
(1) CLS, Space Oceanography Division, Ramonville St Agne, France; (2) CLS, Dos, pmc, Ramonville St Agne, France; (3) CNES, Toulouse, France

Since the first altimeter missions and the improvements performed in the accuracy of sea surface height measurements from 1992 onwards, the importance of global quality assessment of altimeter data has been increasing. Global Cal/Val studies are usually performed by the analysis of internal consistency and cross-comparison between all missions. In this study, the steric and mass contributions to the sea level provided by Argo profiling floats and the Gravity Recovery And Climate Experiment (GRACE) mission respectively are used as independent sources of comparison to analyze the altimetry errors.

Argo profiling floats are spread out over almost the global open ocean since 2004. However, they measure temperature and salinity vertical profiles, providing only the steric contribution to the total sea level content measured by altimeters. The missing mass contribution is derived from the GRACE data set from 2003 onwards.

The comparison is performed with the first objective of detecting global and regional altimeter mean sea level drifts. A second goal is to assess the impact of the new altimeter standards (orbit, geophysical corrections, ground processing) and new versions of altimeter merged products such as the 2014 Aviso reprocessing or the Sea Level CCI data set. We also focus our work on sensitivity analyses of the method of comparison to various parameters. In particular, we determine to which extent the altimeter quality assessment is affected by a different pre-processing and systematic sub-sampling of the Argo network and a change of the reference depth used to compute Argo dynamic heights.

An upper limit of future sea-level rise
A. Levermann (1)
(1) Potsdam Institute for Climate Impact Research, Research Domain Sustainable Solutions, Potsdam, France

For coastal protection an upper limit of future sea-level rise is of much higher value than the likely range provided by the Intergovernmental Panel on Climate Change AR-5. Based on state-of-the-art process-based simulations and physical considerations, an upper limit for the global mean sea-level rise of the 21st century is presented. It is shown that this upper limit is consistent with the upper range provided by the IPCC AR5, but far exceeds the upper value of this likely range. For practical purposes a full probability distribution is suggested which is both consistent with the IPCC range and the upper limit estimate.

Climate change impacts on Nef Glacier and repercussions on the hydrological regime of Nef River (Patagonia, Chile)
P. Lopez (1) ; B. Pouyaud, (2) ; P. Chevallier, (2) ; G. Casassa, (3) ; F. Espinoza, (4) ; J. Salas, (5) ; P. Nahuelpan, (5) ; J. O’Kuignhtons, (5) ; L. Longuevergne (6)
(1) CNRS, University Rennes 1, Geosciences Rennes, Rennes, France; (2) Laboratoire Hydrosciences UMR 5569 (CNRS, IRD, Université de Montpellier), Montpellier, France; (3) Geoestudios Ltda and Universidad de Magallanes, Santiago and Punta Arenas, Chile; (4) Independent consultant, Coyhaique, Chile; (5) Dirección General de Aguas, Coyhaique, Chile; (6) CNRS, University Rennes 1, Geosciences Rennes, Rennes, France

The Nef River, with its origin in the Nef Glacier, located on the Northern Patagonia Icefield (Chile), drains a glacierized basin of 800 km². In this study, fluctuations between 2005 and 2010 in the discharge of Nef River melted close to the glacier front, were analyzed. Throughout the whole data series, the discharge follows a seasonal fluctuation with a mean discharge of 27.1 m³/s and 78.3 m³/s for the fall/winter and spring/summer season, respectively. During autumn, spring, and summer, several floods are related in terms of temperature peaks. The highest flood of the whole period (189 m³/s) was observed on 11 March 2009 and occurred as a result of a significant increase of the air temperature (from –0.9°C to +12.5°C) appeared during the 5 previous days to the flood triggering increase of glacier melting.

In order to quantify the Nef Glacier’s melting (in function to the air temperature) during spring and summer seasons, a simplified degree-day method was applied for the 2007-2008 hydrological year (which is the only period without gaps on the data series). The glacier melt water contributed for 30% to the total discharge; meanwhile precipitation represents only a 7.2%.

In addition, we found that Glacial Lake Outburst Flood (GLOF) events occurred at Nef Norte Lake (a small proglacial lake originated on a lateral front of Nef Glacier) can contribute significantly to the discharge from Nef River. Indeed, the surface area of the lake was monitored using Spot 5 satellite images and DEMs. By 23th March 2008, the lake lost at least 25% of the surface measured in 13th March and the water level of the lake was 33.6 m lower (equivalent to 6*106 m³). This amount is therefore coherent with the increase of discharge of 25.3 m³/s recorded between 15th and 20st March 2008.

In consequence, we suggest that a GLOF event was responsible of the 4th highest flood (156.8 m³/s) of the 2005 - 2010 period.

GLOF events, which increased their frequency in Patagonia during the last decade, are the clear evidence of constant glacier thinning as response to climate change. The ablation area of Nef Glacier thinned 1.8 m between 2001 and 2011.

These results confirm that a hydrological approach applied to the glacial runoffs can correctly estimate glacier melting coming from ablation area, which is largely unknown at basin scale in the Northern Patagonia Icefield.

Recent acceleration of glacier retreat in the Northern Patagonia Icefield based on an updated decennial evolution
P. Lopez (1) ; G. Casassa, (2)
(1) Geosciences Rennes, Rennes, France; (2) Geoestudios Ltda and Universidad de Magallanes, Santiago and Punta Arenas, Chile

The glacier length fluctuations and the surface area evolution between 2001 and 2011 of 25 glaciers of the Northern Patagonia Icefield (NPI) were studied by using the information extracted from the Landsat ETM+ satellite image of 11 March 2001 was compared to the measurements performed based on the Landsat ETM+ satellite image of 19 February 2011. From a global point of view, the majority of the studied glaciers retreated and lost surface between 2001 and 2011, only few glaciers (Leones, Nef, Patagon Sur and Feo) located on the eastern side of the NPI have been stable. Glaciers located on the western side of the NPI suffered a stronger wasting compared to the glaciers located on the eastern side.

Between 2001 and 2011, a noteworthy retreat of 1.9 km was experienced by Gualas Glacier and by Reichert Glacier with a total retreat of almost 6 km from the front. The eastern side of the NPI, on the south-western side of the NPI, during the same decennia, Steffen Glacier experienced a remarkable retreat of 1.6 km as well. During the 2001–2011 period, Steffen Glacier more than doubled its rate of retreat (compared to the 1979–2001 period) and experienced the disintegration of its main front as well as a lateral tongue that retreated
ABSTRACT BOOK

3.1 km. The most significant retreat observed on the eastern side was experienced by Colonia Glacier (1 km).

Area loss was also relevant during the period 2001–2011. Overall, the icefield experienced a reduction of 50.6 km² which represents a 2.3% relative to the total mass calculated for 2001 year. The most remarkable surface reduction was observed for HPN-1 Glacier that lost 3.2% of its surface estimated in 2001, followed by Steffen Glacier (2.8%).

We suggest that the glacier shrinking observed in the NPI is controlled firstly by atmospheric warming, as it has been previously observed in this region. Models, updated climatic studies are needed in order to confirm this suggestion. If the detected past climate trends persist, in the future, glaciers of the NPI will continuous or even increase their rate of melting (Wandel and others, 2007). Therefore, studies such as this region like the production of Glacier Lake Outburst Flood events or the decrease of the melt–water runoff in the long-term future.

P-1107-13

Use of Differential SAR Interferometry for vertical ground motions monitoring in coastal cities
D. Raucoules (1) ; G. Woppelmann (2) ; G. Le Cozannet (1) ; M. De Micheile (1)

(1) BRGM, ORLEANS, France; (2) LIENSS - univ la Rochelle, La Rochelle, France

Before the altimetry era, tide gauge are a unique source of information to evaluate past sea-level changes. However, they can be affected by vertical ground motions acting at different scale spaces. We use synthetic aperture radar techniques to assess these ground motions and their consequences for geodetic instruments such as Tide Gauge, GPS, Doris stations. Summarizing results obtained at Alexandria (Egypt; Woppelmann et al., 2013), Manila (Philippines; Raucoules et al., 2013) and Dakar (Senegal; Le Cozannet et al., subm.), we identify different situations in terms of data availability and ground motion context:
- when strong ground motions affect the tide gauge, the technique can easily help rejecting tide gauges records from the database of reliable datasets (case of Manila - however, when no ground motions can be observed using InSAR in the vicinity of geodetic instruments (Case of Alexandria and Dakar), it remains challenging to reach the accuracy required to confirm that tide gauge records are indeed suitable for monitoring sea level changes. To reach the needed accuracy of this InSAR application, a large set of SAR data must has been acquired over the area. For future science application of Sentinel 1 in the field of geodesy underpinning sea level science, it will be necessary to define appropriate background missions covering coastal cities where key records have been acquired.

P-1107-14

Sea level rise and Geoid: Factor analysis approach
A. Sadovski (1) ; H. Song, (2) ; G. Jeffress, (2)

(1) TexasA&M University–Corpus Christi, Corpus Christi, TX, United States of America; (2) Texas A&M University–Corpus Christi, Corpus Christi, TX, United States of America

Sea levels are rising around the world, and this is a particular concern along most of the coasts of the United States. A 1989 EPA report shows that sea levels rose 5–6 inches more than the global average along the Mid–Atlantic and Gulf Coasts in the last century. The main reason for this is coastal land subsidence. This sea level rise is considered more as relative sea level rise than global sea level rise. Thus, instead of studying sea level rise itself, this paper describes a statistical approach by using factor analysis of regional sea level rates of change. Unlike physical models and semi–empirical models that attempt to approach how much and how fast sea levels are changing, this methodology allows for a discussion of the factor(s) that statistically affects sea level rates of change, and seeks patterns to explain spatial correlations.

Cartographers and geodesists, those who study the measurement of the size and shape of the earth, are interested in sea level as an elevation datum. This datum is used to represent the geoid, which is defined as the equipotential gravity surface of the Earth, and theoretically best fits global mean sea level in ocean areas. Hence, the rate of change in mean sea level directly affects changes to the geoid and the elevation datum used as the reference for topographic mapping.

Many methods have been used in sea level rise modeling. These methods can be divided into two categories: physical models, based on the conservation of mass (global water mass and ice mass measurements), and semi–empirical models, studying measured rates of change of sea level and measured changes in global temperatures along with the error estimates of measurements to predict future trends. These two approaches are complementary. For example, no one really understands the dynamics of each and every glacier, so it is quite difficult to calculate melting of glaciers from physical models, hence the use of semi–empirical methods described in the majority of studies of sea level rise. This paper introduces a different approach by using factor analysis of regional sea level rates of change as a statistical analysis tool. Instead of answering the question of how much and how fast sea levels are changing, this paper computes and discusses which mathematical factor statistically affects sea level rates of change and seeks patterns to explain spatial correlation. The paper also seeks to hypothesize that any insights into the factors influencing sea level change also apply to the changes to the geoid.

P-1107-15

Strategy and new statistical downscaling method for the on-line derivation of the Greenland ice sheet surface mass balance in a GCM
D. Salas Y Melia (1) ; M. Geyer (1) ; E. Brun (2) ; M. Dumont (3)

(1) CNRM–GAME (METEO–FRANCE/CNRS), CMGEC/ASTER, Toulouse, France; (2) ONERC, Paris, France; (3) CEN, Grenoble, France

Current CMIPs (Coupled Model Intercomparison Project Phase 5) coupled Global Climate Models (GCMs) cannot realistically represent ice sheet/climate feedbacks. This is due to their coarse horizontal resolution, which hampers the correct representation of Surface Mass Balance (SMB) spatial variability, to weaknesses in the representation of physical processes at the ice sheet surface and to the lack of interactive ice sheet models which are necessary to represent the ice loss due to dynamics. As a contribution to the future inclusion of interactive ice sheet models in coupled GCMs, we discuss various potential methods. We present a downscaling method designed for the online derivation of the SMB field over the Greenland ice sheet (GrIS). This method uses statistical relationships between SMB and temperature and precipitation variations which have been established from off-line simulations of the SMB performed on a high resolution grid with a detailed snowpack model. We used this technique to downscale 150 km horizontal resolution SMB output from the CNRM–CM5.1 GCM to a 15 km resolution grid. A comparison with output from the MAR regional model shows that the downscaling clearly improves the spatial distribution of the SMB, particularly in Greenland interior, where topography gradients are not correctly represented at low-resolution. A simulation where CNRM–CM5.1 was nudged with ERA–Interim demonstrates the ability of the method to reproduce realistic regional variability of the total GrIS SMB from 1979 to 2012. From a technical point of view, the method is generic enough to be applied to outputs from other GCMs, though it cannot completely filter model biases, especially in the interior of the GrIS.

P-1107-16

Sea level change and projection for future flooding along the coast off Egypt
M. Shaltout (1)

(1) Faculty of Science, Alexandria University, Egypt., Physical Oceanography, Alexandria, Egypt

The current study analyses the recent changes in the daily satellite altimetry data along the southern Levantine sub-basin and cost off Egypt over the period 1993–2013. First,
the accuracy of using satellite altimetry data, represented by dynamical topography (DT) as a measure of coastal sea levels, is examined based on tide gauges observations. Second, daily and annual satellite altimetry data are related to five atmospheric/oceanic factors to evaluate their effect on DT changes. Third, the sensitivities of three realizations of the Geophysical Fluid Dynamics Laboratory (GFDL) global climate model (GCM) are examined by comparing these with the satellite altimetry dataset. Finally, the simulations that best describes the present satellite altimetry data are used to describe the uncertainties in projection of the sea level changes along the study area.

The results indicate that the satellite altimetry data represented by DT can be used to study coastal and deep sea level changes in the study area. Southern Levantine sub-basin sea level display a recent average sea level rise of 3.1 cm decade−1 and exhibits a significant annual sea level variation from −17 cm (deep water) to 8 cm (shallow water). The sea level variations are significantly affected by several factors such as and in order of importance: sea level variations west of Gibraltar Strait, steric sea level variations and sea surface temperature. The GCMs that most realistically describe the recent sea level over the study area is GFDL–CM3, outputs from this model are used to study the projected sea level along the study area for different emission scenarios. GFDL–CM3 model results indicate that the coast of Egypt will experience sea level rise in the current century. Uncertainty in the projected sea level rise over the studied area ranged from 4 to 22 cm rise by 2100 and was explained by three different sources of uncertainties, of which the emission assumed dominated. Comparing of uncertainty in the projected sea level rise with digital elevation data shows that the Egyptian Mediterranean coast will only become safe from flooded by the end of 21st century if effective adaptation methods are applied.

P-1107-17
Earth's changing oceans: Effects and implications for iceberg calving from Antarctica's ice shelves

C. Walker (1)
(1) Georgia Institute of Technology, School of Earth and Atmospheric Sciences, Atlanta, GA, France

Ice shelves are freely floating seaward extensions of the Antarctic ice sheet. They can extend hundreds of kilometers into the ocean and drain the vast majority of ice from Antarctic ice sheet to the ocean. Iceberg calving from these ice shelves is the primary means of discharging ice from the Antarctic Ice Sheet into the Southern Ocean and, although calving events occur sporadically, when they do occur they remove large amounts of mass in a nearly instantaneous process. This cycle forms part of the natural cycle of the ice shelves, and although calving events can occur at any time, there are cyclic variations in the frequency of calving events. For example, the Larsen A and Larsen B ice shelves in Antarctica have experienced increased calving activity in recent years, which has far-reaching implications for the stability of the Antarctic ice sheet. Understanding the factors that drive calving events is essential for predicting the future of Antarctica's ice shelves.

Many major and minor ice shelves of Antarctica exist in a colder climate further South than the peninsular ice shelves and have not experienced comparable surface warming nor are they currently showing any signs of peninsular–style disintegration. They have, however, experienced increased basal melting over the past decade with some speculation that these ice shelves may especially be susceptible to ocean forcing. To realistically assess the evolution of ice shelves it is necessary to investigate the precursor to calving: the initiation and propagation of rifts through the ice. As ice flows toward the open water rifts eventually become the boundaries at which icebergs separate from their parent ice shelf. An example of such a rift was detected in October 2011, at Pine Island Glacier (PIG) in West Antarctica. The PIG flows outward into the Amundsen Sea, creating a 30-km floating ice tongue. As the floating shelf elongates from the grounding line, cracks eventually form and icebergs calve off later. Riffs can initiate far upstream of the calving front and propagate for decades before an iceberg detaches. While many studies have examined the dynamics of vertical crevasse penetration, fewer studies have examined lateral propagation and little is currently known about the processes that drive rift propagation. For example, it has been proposed that rifts are the cumulative result of internal stresses, environmental changes, and other factors. In order to reverse and stabilize sea level rise, it is essential to understand the factors that drive calving events and the implications for the future of Antarctica's ice shelves.

P-1107-18
The Irreversibility of Sea Level Rise

K. Zickfeld (1); K. Tokarska (2)
(1) Simon Fraser University, Vancouver, BC, Canada; (2) University of Victoria, Victoria, Canada

Recent research has shown that sea level continues to rise even if carbon dioxide emissions are halted completely. Here we explore whether artificial atmospheric carbon dioxide (CO2) removal (also referred to as “negative emissions”) has the potential to reverse thermosteric sea level rise on timescales relevant to human civilization. Specifically, we investigate how much CO2 needs to be removed from the atmosphere for sea level rise to be reversed and stabilized permanently, and the degree to which the reversibility of the sea level rise depends on the amount and duration of CO2 emissions prior to the time of artificial CO2 removal. To investigate these questions, an Earth System model of intermediate complexity is forced with a range of emission scenarios entailing different amounts of net negative CO2 emissions. We find that in order to reverse and stabilize sea level rise, atmospheric CO2 concentrations need to be returned to pre-industrial levels. Thermosteric sea level rise is linked to the integrated net radiation flux at the top of the atmosphere, and will stop rising only when this flux becomes negative (i.e. when there is a net radiation loss to space). Our results suggest that while sea level rise can be reversed temporarily with negative emission technologies deployed at a scale that is currently deemed to be technologically feasible, reversal and permanent stabilization of sea level rise requires the removal of all anthropogenic CO2 from the atmosphere.
Future stratospheric ozone in a changing climate

U. Langematz (1)
(1) Freie Universität Berlin, Institut für Meteorologie, Berlin, Germany

As a result of the Montreal Protocol on Substances that Deplete the Ozone Layer and its subsequent amendments and adjustments that constrained the production and consumption of halocarbons, the decline of stratospheric global ozone seems to have ceased. Model projections suggest a future recovery of the global mean ozone column to levels around the year 2080, when only low levels of ozone depleting substances (ODSs) exist in the stratosphere. However, the timing of the return of ozone to historical levels depends not only on the concentrations of ODSs but is also affected by thermal and dynamical changes associated with increasing greenhouse gas concentrations. For example, while the amounts of ODSs steadily decrease in the stratosphere, with appropriate meteorological conditions and given the long lifetimes of ODSs, individual years with strong ozone decrease still may occur in the near future.

Here, an overview of future projections of the ozone layer based on chemistry–climate model simulations will be presented. The impact of climate change on stratospheric ozone recovery will be discussed.

Stratosphere–Troposphere Coupling in a Changing Climate

M. Baldwin (1)
(1) University of Exeter, Exeter, United Kingdom

Stratospheric variability and change has substantial effects on surface weather and climate, especially on the Annular Modes, with shifts in the jet streams, storm tracks, precipitation, and likelihood of blocking events. Despite unambiguous observations of this phenomenon, as well as numerical simulations, a clear physical explanation of this downward coupling has been elusive. In this talk I will discuss recent advances in our understanding—how pressure changes (movement of mass) in the stratosphere affects surface climate. However, movement of mass in the stratosphere is not sufficient to fully explain the observed surface changes, and feedbacks associated with temperature changes that would be expected theoretically, and are larger than at the tropopause. This “tropospheric amplification” is easily quantified, and suggests a role for eddy feedbacks in response to the movement of mass. I will discuss the future implications for surface climate, jets, storm tracks, etc.—assuming that we know how the stratosphere will change during the remainder of this century.

Sub-seasonal climate predictability associated with an anomalously strong stratospheric polar vortex

A. Charlton-Perez (1); O. Tripathi, (1); M. Sigmond, (2); F. Vitart, (3)
(1) University of Reading, Meteorology, Reading, Berkshire, United Kingdom; (2) Environment Canada, Canadian centre for climate modelling and analysis, Victoria, Canada; (3) ECMWF, Reading, Berkshire, United Kingdom

There has been a great deal of recent interest in producing weather forecasts on the 2–6 week sub-seasonal timescale which bridges the gap between medium-range (0–10 day) and seasonal (3–6 month) forecasts. While much of this interest is focused on the potential applications of skilful forecasts on the sub-seasonal range, understanding the potential sources of sub-seasonal forecast skill is a challenging and interesting problem particularly because of the likely state-dependence of this skill (Hudson et al., 2011). One such potential source of state-dependent skill for the Northern Hemisphere in winter is the occurrence of stratospheric sudden warmings (SSWs) events (Limpasuvan et al., 2013). Here we show, by analysing a set of sub-seasonal hindcasts, that there is enhanced predictability of surface temperature and circulation not only when the stratospheric vortex is anomalously weak following SSWs but also when the vortex is extremely strong. During the third and fourth weeks following anomalously strong polar vortex conditions northern Europe and northern Russia are on average three degrees colder than their climatic norm, with similarly sized cold anomalies over northwestern North America. Sub-seasonal forecasts initialised during strong vortex events are able to successfully capture their associated surface temperature and circulation anomalies. This results, for some regions, in a significant enhancement of forecast skill compared to forecasts initialised during cases when the stratospheric state is close to climatology. We demonstrate that the enhancement of skill for forecasts initialised during periods of strong vortex conditions is comparable to that achieved for forecasts initialised during SSW events. This result indicates that additional confidence can be placed in sub-seasonal forecasts when the stratospheric polar vortex is significantly disturbed from its normal state. This presentation will discuss this result and its implications for understanding the impact of stratospheric climate change and its tropospheric impact.

Characteristics of stratospheric warming events during Northern Winter

P. Maury, (1); C. Claud (1); E. Manzini (2); A. Hauchecorne (3); P. Keckhut (4); K. Kodera (5)
(1) CNRS, Iplsp/lmd, Palaiseau, France; (2) Max Planck Institut, Hamburg, Germany; (3) Cnrs, ipsl/lmd, Palaiseau, France; (4) LATMOS/IPSL, Guyancourt, France; (5) Solar–Terrestrial Environment Laboratory, Nagoya university, Nagoya, Japan

The polar mid–stratosphere is characterized by the setting up of westerly winds around the pole during the winter time; the so-called polar vortex. The polar vortex is one of the most variable features of the zonal–mean circulation of the earth atmosphere, due to a highly non linear interaction between planetary–scale Rossby waves and the zonal flow. Indeed, the interaction between the upward tropospheric propagating waves and the polar vortex leads to a zonal flow weakening, implying a large day–to–day vortex variability. In the most dramatic cases, the polar vortex breaks down, the stratospheric polar flow can reverse its direction and the temperatures can rise locally by more than 50K in a span of a few days. Such phenomena are known as major Sudden Stratospheric Warmings (SSWs) and constitute, since their discovery in 1952 (Scherhag,1952), the most impressive dynamical events in the physical climate system. On the contrary, situations where the temperature increase is not associated to a polar vortex breakdown are known as minor SSWs.

There is actually a renewed interest about SSWs since Baldwin and Dunkerton (2001) have shown that the major SSWs can influence weather in the troposphere. This stratospheric–tropospheric linkage has been strongly highlighted but no physical explanation has been proposed. Also, other studies, that incorporate both major and minor SSWs, show that events in the stratospheric zonal flow associated with SSWs present downward propagating anomalies that can reach the troposphere (Limpasuvan et al 2004), implying that minor SSWs have to be also considered in the study of the stratospheric–tropospheric dynamical coupling.

In this study, we propose a global characterization of stratospheric warmings situations based on a temperature threshold in the 50–10 hPa layer between 70N and 90N, in order to better assess the properties of daily stratospheric temperature variability during the northern winter. The originality of this approach consists in evaluating the wintertime positive temperature anomalies in terms of intensity and duration without distinction between minor and major SSWs. We will show that there is a wide
spectrum of warming types, where major SSWs are the most extreme, but also the minor SSWs - share some common properties with them. They can even have a surface signature if one looks the stratospheric wave reflection on the polar vortex.

**O-1108-03**

**Update of stratospheric temperature interannual variability and trends from space sounders and ground-based lidars observations**

A. Hauchecorne (1); P. Keckhut (1); C. Claud (2); B. Funatsu, (2); A. K. Khosrawi, (1); G. A. Frey, (1); P. Maury, (2)

(1) LATMOS-JPSL, Guyancourt, France; (2) CNRS, lisp/lmd, Palaiseau, France; (3) CNRS, Létg–rennes costel, université rennes2, Rennes, France

The stratosphere is expected to cool, in conjunction with the global warming at the surface and in the troposphere, due to the increase of greenhouse gas concentration in the atmosphere, and also to stratospheric ozone loss. This is already observed but the rate of cooling is not constant and there is still a debate on its amplitude. Several other factors may influence the evolution of the stratospheric temperature: External forcings, like the solar variability that modulate the UV solar flux and strong volcanic eruptions injecting aerosols in the stratosphere, participate to its decadal variability. The variability of the stratospheric dynamics is also adding some complexity to the system. For instance global climate models predicts an increase of the occurrence frequency of sudden stratospheric warming (SSW) events not yet confirmed by the observations. A better understanding of stratospheric temperature evolution is crucially needed to better understand the complexity of the processes playing a role in the coupling between the stratosphere, the troposphere and the climate.

The stratospheric temperature is measured at a global scale by satellite instruments; mainly microwave sounders AMSU (Advanced Microwave Sounding Unit) on board meteorological satellites. These sounders are very useful to provide the global overview but may suffer from biases and orbital drifts and have a poor vertical resolution in the upper stratosphere. Since 2000 radio–occultation sensors, among which the TAO-C (Tahiti–Aloha–Coral) provided well-resolved and accurate temperature profiles but limited to the upper troposphere–lower stratosphere. Rayleigh lidars implemented within the NDACC (Network for the Detection of Atmospheric Composition Change) international network measure accurately the temperature profile from the middle stratosphere to the upper mesosphere but in a very few locations. They are used for climate change monitoring, dynamics studies and satellite validation.

In this presentation we will present an update of the interannual variability and trends in the stratospheric temperature from AMSU, Rayleigh lidar and radio–occultation measurements. Similarities and differences in the temperature evolution captured by these various sensors will be evaluated. The contribution of anthropogenic and natural forcings to the observed changes will be discussed. A particular focus will be given to the role of SSW events to the stratospheric temperature evolution as a function of latitude and seasons.

**O-1108-04**

**Role of the middle atmosphere for low-frequency climate variability**

T. Rechler (1); Z. Bowen (1)

(1) University of Utah, Atmospheric Sciences, Salt Lake City, Utah, United States of America

It is commonly believed that the ocean represents the dominant source for climate variability on longer, interdecadal time scales and that this drives the low-frequency variations in the atmosphere. The ocean-atmosphere system provide evidence for the existence of opposite pathways. Investigating long control simulations with coupled and uncoupled climate models we find considerable multi-decadal variability in the atmosphere that is independent of the ocean and that influences climate. The middle atmosphere represents one source for such low-frequency variability. The variability is related to relatively long-lived fluctuations in the strength of the stratospheric polar vortex, which in turn project on the state of the North Atlantic Oscillation. This creates signals in ocean temperatures over the deep convective region to the south of Greenland, which, over the course of several years, propagate into the deep ocean. These events modulate the UV solar flux and strong volcanic eruptions injecting aerosols in the stratosphere, participate to its decadal variability. The variability of the stratospheric dynamics is also adding some complexity to the system. For instance global climate models predicts an increase of the occurrence frequency of sudden stratospheric warming (SSW) events not yet confirmed by the observations. A better understanding of stratospheric temperature evolution is crucially needed to better understand the complexity of the processes playing a role in the coupling between the stratosphere, the troposphere and the climate.

The stratospheric temperature is measured at a global scale by satellite instruments; mainly microwave sounders AMSU (Advanced Microwave Sounding Unit) on board meteorological satellites. These sounders are very useful to provide the global overview but may suffer from biases and orbital drifts and have a poor vertical resolution in the upper stratosphere. Since 2000 radio–occultation sensors, among which the TAO-C (Tahiti–Aloha–Coral) provided well-resolved and accurate temperature profiles but limited to the upper troposphere–lower stratosphere. Rayleigh lidars implemented within the NDACC (Network for the Detection of Atmospheric Composition Change) international network measure accurately the temperature profile from the middle stratosphere to the upper mesosphere but in a very few locations. They are used for climate change monitoring, dynamics studies and satellite validation.

In this presentation we will present an update of the interannual variability and trends in the stratospheric temperature from AMSU, Rayleigh lidar and radio–occultation measurements. Similarities and differences in the temperature evolution captured by these various sensors will be evaluated. The contribution of anthropogenic and natural forcings to the observed changes will be discussed. A particular focus will be given to the role of SSW events to the stratospheric temperature evolution as a function of latitude and seasons.

**O-1108-05**

**The millennium water vapour drop in the stratosphere in chemistry-climate model simulations**

S. Brinkop (1); M. Dameris (1); P. Jöckel, (1); H. Garny, (1); S. Lossow, (2); G. Stiller (2)

(1) DLR–Deutsches Zentrum fuer Luft- und Raumfahrt, Institut fuer Physik der Atmosphaere, Oberpfaffenhofen, Germany; (2) KIT – Karlsruher Institut fur Technologie, Imk­ asf, Karlsruhe, Germany

This study investigates the millennium water vapour drop, the abrupt and severe water vapour decline in the stratosphere beginning year 2000, by means of various simulations using the Chemistry–Climate Model (CCM) EMAC. Some selected stratospheric water vapour measurements and corresponding satellite measurements starting in the early 1990s indicated that the water vapour concentrations observed from satellite from 1992 to 2012 are not reproduced by CCM simulations forced by observed changes in sea surface temperatures, greenhouse gases and ozone-depleting substances (Gettelman et al., 2010, Randel and Jensen, 2013).However, the CCM EMAC is able to reproduce the signature and pattern of the water vapour disturbances inagreement with those derived from observations. In this paper we present results of a hierarchy of simulations with the CCM EMAC, demonstrating that it is possible to retrace the observed water vapour fluctuations in the stratosphere (incl. the millennium drop), if suitable inner and outer boundary conditions are applied.

**1108–POSTER PRESENTATIONS**

**P-1108-01**

**The ARISE project: dynamics of the atmosphere and climate**

E. Blanc (1); A. Charlton-Perez (2); P. Keckhut (3); L. Evers (4); P. Heinrich (1); A. Le Pichon (1); A. Hauchecorne (5)

(1) CEA, Arpajon, France; (2) University of Reading, Department of meteorology, Reading, United Kingdom; (3) LATMOS–IPSJ, Guyancourt, France; (4) Royal Netherlands Meteorological Institute (KNMI) , De Bilt, Netherlands; (5) CNRS, Latmos, Guyancourt, France

It has been robustly demonstrated that variations in the circulation of the middle atmosphere influence weather and climate throughout the troposphere all the way to the Earth’s surface. A key part of the coupling between the troposphere and stratosphere occurs through the propagation and breaking of planetary waves and gravity waves. Limited observations of the middle atmosphere and these waves in particular have a tendency to fail to reproduce the dynamics of the middle atmosphere in numerical weather prediction and climate models.

An exciting scientific development in recent years has been the potential of a number of novel ground-
based measurement techniques to give new and complementary measurements of the middle atmosphere. The main challenge of the ARISE (Atmospheric dynamics InfraStructure in Europe) project[1] is to combine for the first time existing national and international observation networks to observe the middle atmosphere including the International infrasound monitoring system developed for the CTBT (Comprehensive nuclear–Test–Ban Treaty) verification, the NDACC (Network for the Detection of Atmospheric Composition Changes) lidar network, localized European observation infrastructures at mid latitudes (OHP observatory), tropics (Maido observatory), high latitudes (ALOMAR and EISCAT), infrasound stations developed at the international infrasound monitoring system developed networks which observe the middle atmosphere including innovative instrumentation for measurements in the middle atmosphere between 40 and 80 km where temperature and wind measurements are especially rare. This joint network provided advanced data products, with the scope to assemble the derived upper atmosphere wind and temperatures into NWP models. The ARISE infrastructure is unique because of its coverage (from polar to equatorial and tropical regions in the European longitude sector and adjacent regions), its ability to sense a wide range of processes in the middle atmosphere (mesosphere, mesopause, lower thermosphere, ionosphere) and the involved scales both in time (from seconds to tens of years) and space (from tens of meters to thousands of kilometers). We are about to embark upon a new phase of development to allow the network to be improved by (i) including innovative instrumentation for measurements in the middle atmosphere, (ii) which makes them insensitive to the annual cycle traditionally assumed an arbitrarily uniform source of gravity waves, (iii) adding measurements in low latitude African stations where only infrasound observations are currently available, and (iv) by automating lidar and radar measurements for routine observations. The major ARISE objective is to provide a full description of gravity wave parameterization in the stratosphere and mesosphere for wave parameterization and assimilation in the models. This could lead to a better prediction of extreme events such as Sudden Stratospheric Warming and improvement of the tropospheric weather forecasts on weekly time scales. The societal impact is potentially very large, including for sectors such as agriculture, energy consumption, transport, insurance and risk quantification. ARISE objectives are also (i) to better characterize the coupling between atmospheric layers and effects on the global atmospheric circulation and climate, (ii) to quantify the trends in extreme events related to climate, (iii) to determine the impact of the Earth’s geo-space. The project is multidisciplinary and includes European groups with complementary expertise in weather forecasting, climate, extreme events monitoring. It has partners in a number of international organizations including the ECMWF (European Centre for Medium-Range Weather Forecasts), WMO (World Meteorological Organization), SPARC (Stratospheric Processes And their Role in Climate), ROSMIC (Role Of the Sun and the Middle atmosphere–thermosphere–ionosphere In Climate), IRGGEA (International Research Group in Geophysics Europe Africa). This presentation will review recent advances in this topic especially obtained in the framework of the ARISE project. It will also discuss perspectives and future project challenges related to climate.

[1] ARISE is an infrastructure Design study project funded by the European Commission under the H2020 program. **P-1108-02**

**Stratospheric chemistry-climate interactions and their importance for the surface climate in Antarctica**

P. Braesicke (1); J. Keeble (2); L. Abraham (3); S. Killmann (1); J. Pyle (2); G. Stiller (1); X. Yang (4)

(1) KIT, IMK–ASF, Egggenstein–Leopoldshafen, Germany; (2) University of Sheffield, Ncas, Cambridge, United Kingdom; (3) University of Cambridge, Ncas, Cambridge, United Kingdom; (4) BAS, British Antarctic survey, Cambridge, United Kingdom

One prominent example of anthropogenic environmental change is the annually recurring ozone hole in the Southern Hemisphere. This schematic change in stratospheric composition affects circulation and tropospheric climate. To improve our understanding of how a stratospheric change induces shifts in tropospheric climate, we investigate model integrations run with the fully coupled chemistry climate model UM–UKCa. Results are confronted, where appropriate, with satellite observed changes from the MIrAPS instrument on ENVISAT.

Comparing two climate–equilibrium runs with and without an ozone hole we find statistically significant changes in the models thermal structure and circulation. Polar lower stratospheric cooling in comparison with the control run late in the high latitude tropopause and followed by an increase in the vertical component of the EP flux from November to December are consistent with a surface warming of the Antarctic Peninsula. The seasonal change of circulation is accompanied by an apparently descending anomaly of the EP flux divergence in the stratosphere, thus suggesting an active role of stratospheric dynamics in the surface response.

The robustness of such a circulation response to ozone changes can be studied using differences of long-lived trace gas distributions in different model climate equilibrium states with different ozone amounts. We conclude that the climate system can respond sensitively (but coherently) in its seasonal evolution to small chemical perturbations and the circulation adjustment and seasonal change are observed interannual variability. This finding supports the applicability of the UM–UKCa climate equilibrium runs to the interpretation of the Antarctic Peninsula warming.

**P-1108-03**

**Stochastic parameterizations of the gravity waves emitted from convection and fronts: theory, validation, and impacts of the middle atmospheric circulation**

A. De la Camara (1); F. Lott, (1); L. Guez, (1); A. Hertzog, (1)

(1) Laboratoire de Météorologie Dynamique, Paris, France

Internal gravity waves (GWs) propagating vertically from their tropospheric sources impact the circulation of the middle atmosphere, and are crucial for the reversal of the mesospheric jet and the maintenance of the quasi-biennial oscillation. Their spatial scales being too small to be represented in current Earth System models, they need to be parameterized. Nevertheless, mechanisms for GW emission by fronts and jets remain elusive nowadays. As a result, non-orographic GW parameterizations have traditionally assumed an arbitrarily uniform source of waves, which makes them insensitive to the annual cycle of the GW sources or to a changing climate. For these reasons, much effort has been made over the last decade to develop schemes that relate the GWs to their sources. A recently developed stochastic parameterization of gravity waves is used and adapted to represent the gravity waves produced by convection and mid-latitude fronts. For the fronts, the parameterization underpins the theory of the spontaneous adjustment that relates directly the gravity waves field to potential vorticity anomalies. With relatively little modification to the theory, we show that the spontaneous adjustments occurring in the troposphere are sufficient to produce the right amount of waves in the mesosphere. We also predict the gravity wave field present during the Concordiasi long–duration balloon campaign in the lower stratosphere, a gravity waves field predicted by the parameterization are quite realistic. The impacts on the climate are also addressed with the General Circulation Model LMDz, with a particular emphasis on the annual cycle in the stratosphere. We also address the applicability of including the GWs sources on the middle atmosphere response to a changing climate. Preliminary results show that when GW sources are included, the middle atmosphere response to a changing climate is stronger than without the sources, the impacts even reaching the surface at least in the Southern Hemisphere.


On the coupling between polar and tropical regions during springtime: variability of tropical intrusion and Frozen In Anticyclones

N. Huret (1); R. Thibebmot (2); A. Hauchecorne (3); YJ. Orsolin (4); K. Matthes (2)
(1) LPC2E/CNRS and Orleans University, Orleans, France; (2) GEOMAR, Kiel, Germany; (3) CNRS, Latmos, Guyancourt, France; (4) NILU, Kjeller, Norway

Recent observational and modeling transport studies of Arctic stratospheric final warming have shown that tropical/subtropical air masses can be transported to high latitudes and remain confined within a long-lived “frozen-in” anticyclone (FriAC), embedded in the summer easterlies for several months.

We first present a climatology of these sporadic events over the period 1960–2011 using ERA40 and ERA Interim reanalyses. This study highlights stratospheric favorable pre-conditioning for FriACs occurrence, that is: i) early and abrupt final warming, ii) no stratospheric major warming during the previous winter, and iii) East phase of the Quasi-Biennial Oscillation. We will present in detail the FriAC in spring 2011, which was the largest ever recorded.

Our climatology further suggests that the frequency of occurrence of FriACs has increased over the last decade (among the nine cases detected over the period 1960–2011, five occurred between 2002 and 2011).

A chemistry climate model is then used for the first time to investigate FriACs characteristics and variability. Simulations were performed with the NCAR’s Community Earth System Model (CESM, version 1.0.2), a coupled model system simulating the Whole Atmosphere Climate Community Model (WACCM). FriACs characteristics (i.e. spatial extent and duration), are overall consistent by comparing with FriACs detected ERA40 meteorological reanalyses. Dynamical and radiative feedbacks of the FriACs are associated with an abrupt and early winter-to-summer stratospheric circulation transition, characterized by an amplification of planetary wave activity. Furthermore, our model results confirm that FriACs occur preferentially under the easterly phase of the QBO and in absence of MSW during the preceding winter. Finally, we notice that extreme climate change conditions (RCP8.5 scenario) do not influence FriACs frequency.

Stratospheric ozone causes a negative feedback in CO2-driven climate change simulations

M. Ponater (1); S. Dietmuller, (1); M. Dameris (2); R. Sausen, (1)
(1) DLR-Institut für Physik der Atmosphäre, Earth System Modelling, Oberpfaffenhofen, Germany; (2) DLR, Institut für physik der atmosphäre, Oberpfaffenhofen, Germany

Ozone has been considered mainly as a contributor to climate change in terms of radiative forcing. However, it is also playing a radiative feedback when climate change is induced by, for example, a radiative forcing from CO2 increase. Interactively coupled chemistry–climate models can be used to identify and quantify this feedback. In a set of simulations, CO2-driven climate change impacts from the year 2000 to 2099, are compared to a control simulation. The first target parameters are the tropospheric and stratospheric temperatures and the ozone distribution. The chemical feedback is modified by interaction with the ozone feedback, becoming less negative than in simulations with fixed ozone. Hence, a negative ozone feedback and a reduced water vapour feedback overlap constructively in CO2-driven simulations with interactive ozone, giving a global sea surface temperature response that is 4 to 10% smaller than in a corresponding simulation without interactive chemistry.

Evidence by remote sensing and combined-model approaches for the role of gravity waves in sudden stratospheric warmings

P. Peusse (1); M. Erin, (1); G. Song, (2); T. Trinh, (1); F. Friedl-Vallon, (3); P. Bechtold, (4); HY. Chun, (2); J. Orphal, (3); M. Riese, (1)
(1) Forschungszentrum Juelich GmbH, IEK-7, Juelich, Germany; (2) Yonsei University, Seoul, Republic of Korea; (3) Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany; (4) ECMWF, Reading, United Kingdom

Observations of absolute values of gravity wave momentum flux (GWMF) from the satellite instruments SABER and HIRDLS in conjunction with global stratospheric and mesospheric winds are used to investigate the role of GWs in the different phases of the sudden stratospheric warmings (SSWs) during the recent decade. Both GMWF and its vertical gradient as a proxy for drag are enhanced before the central date of major SSWs. After the central date of the SSW, GMWF and gravity wave drag in the stratosphere are strongly reduced. However, GWs contribute to the downward propagation of newly formed polar jets and of the elevated stratospheric jet stream in the extratropics. This is likely at least in part due to poleward propagation of GWs. In order to shed light on the sources, propagation direction and phase speed spectra of the waves we complement the observations by high-resolution global model fields of ECMWF. We use these fields to infer the characteristics of GWs in the lower stratosphere and couple the results to global ray-tracing. This allows us to a) infer sources of GMWF by backward ray-tracing and b) to study the interaction of GWs in the stratosphere and mesosphere by forward ray-tracing in the background of geostrophic winds inferred from MLS and SABER. The current satellite observations can not reveal the propagation direction of the waves and model data need still to be proven to be fully realistic: the advantages of both approaches would be combined in limb-imaging measurements of a future mission. A concept for such an instrument is presented.

The impact of biogenic bromine emissions from the oceans on the middle atmosphere in a changing climate

BM. Sinnhuber (1); G. Kryssztofiak (2); S. Meul (3)
(1) Karlsruhe Institute of Technology, Institute for Meteorology and Climate Research, Eggenstein-Leopoldshafen, Germany; (2) University of Orleans, LPC2E, CNRS, Orleans, France; (3) Freie Universität Berlin, Berlin, Germany

Bromine from very short-lived substances, primarily from natural oceanic sources, contribute substantially to the halogen loading of the free troposphere and stratosphere with an important impact on atmospheric chemistry. This source of atmospheric bromine has so far been ignored in most chemistry–climate model simulations of tropospheric and stratospheric ozone trends. Here we will present chemistry climate model simulations over the past decades including the biogenic emissions of bromine from the oceans and their impact on atmospheric chemistry and ozone trends. We will discuss possible interactions between oceanic emissions, atmospheric chemistry and climate change.

Network for the Detection of Mesopause Change (NDMC): What can we learn from airglow measurements in terms of better understanding atmospheric dynamics?

S. Wüst (1); M. Bittner (1); C. Schmidt, (1); PJ. Espy (2); J. French (3); F. Mulligan, (4); J. Scheer (5); M. Taylor, (6)
(1) DLR Oberpfaffenhofen, DFD-ATM, Wessling, Germany; (2) Norwegian University of Science and Technology, Trondheim,
Changes in continental water cycle and extreme events

O. Zolina (1)

(1) Joseph Fourier University, Le laboratoire de glaciologie et géophysique de l’environnement, Grenoble, France

Ongoing and projected changes in continental water cycle are closely connected to extreme events with specific mechanisms of water cycle changes. We are going to address observed variability and change in continental water cycle in the context of climate extremes. Although hydroclimate extremes result from many factors that sometimes act together, water is a central component of these extremes via either its excess or scarcity. The major factor underlying hydroclimate extremes is precipitation, closely associated with flooding and droughts resulting from long dry periods and substantial water deficits over large regions. Among the major problems of changes in water cycle associated with extremes we will consider changes in temporal structure of precipitation region (80–100km) from most of the European NDMC stations including spectro-photometers and imagers allow monitoring atmospheric variability at time scales comprising long–term trends, annual and seasonal variability, planetary and gravity waves and infrasonic signals. The measurements also allow validating satellite-based measurements such as from the TIMED-SABER instrument.

Examples will be presented for airglow measurements and for related atmospheric dynamics analysis on the abovementioned spatio–temporal scales and comparisons with satellite–based instruments as well as with LiDAR soundings. Focus will be on climate signals in the mesopause region.

K-1109-03

Changes in continental water cycle and extreme events

O. Zolina (1)

(1) Joseph Fourier University, Le laboratoire de glaciologie et géophysique de l’environnement, Grenoble, France

Ongoing and projected changes in continental water cycle are closely connected to extreme events with specific mechanisms of water cycle changes. We are going to address observed variability and change in continental water cycle in the context of climate extremes. Although hydroclimate extremes result from many factors that sometimes act together, water is a central component of these extremes via either its excess or scarcity. The major factor underlying hydroclimate extremes is precipitation, closely associated with flooding and droughts resulting from long dry periods and substantial water deficits over large regions. Among the major problems of changes in water cycle associated with extremes we will consider changes in temporal structure of precipitation region (80–100km) from most of the European NDMC stations including spectro-photometers and imagers allow monitoring atmospheric variability at time scales comprising long–term trends, annual and seasonal variability, planetary and gravity waves and infrasonic signals. The measurements also allow validating satellite-based measurements such as from the TIMED-SABER instrument.

Examples will be presented for airglow measurements and for related atmospheric dynamics analysis on the abovementioned spatio–temporal scales and comparisons with satellite–based instruments as well as with LiDAR soundings. Focus will be on climate signals in the mesopause region.

K-1109-01

Connections between water and energy: Clouds, water vapour, radiation and precipitation

G. Stephens (1)

(1) JPL, California Institute of Technology, Pasadena, United States of America

Water and energy are intimately coupled together in the Earth’s climate system. Each controls the other. This talk will concentrate on atmospheric feedbacks that develop between water and energy that influence the global hydrological cycle response in a warming and moistening climate. As the planet warms, the amount the global precipitation increases is determined by the increased emission from the atmosphere that is mostly controlled by the increases to water vapor. The increases to water vapor, especially that transported to the upper atmosphere by convection, fundamentally affects the radiation balance both directly through the influence the clear–sky emission and by enhancing the absorption of radiation by the upper tropospheric clouds that develop as a consequence of the moistened upper troposphere. Thus feedbacks develop between radiation, clouds and precipitation that influence how the global hydrological cycle responds to a warmed climate. These feedbacks, and others will be discussed in the context of both global and regional changes to the hydrological cycle.

K-1109-02

Land processes and the global water cycle: Past results and upcoming CMIP6 plans

S. Seneviratne (1) ; B. Van Den Hurk (2) ; G. Krinner (3) ; H. Kim (4) ; C. Derksen (5) ; T. Oki (4)

(1) ETH, Zurich, Institute for atmospheric and climate sciences, Zürich, Switzerland; (2) KNMI, Model Development, De Bilt, Netherlands; (3) LGCE, Grenoble, France; (4) University of Tokyo, Global hydrology and water resources engineering, Tokyo, Japan; (5) Environment Canada, Climate research division, Toronto, Canada


K-1109-03

Changes in continental water cycle and extreme events

O. Zolina (1)

(1) Joseph Fourier University, Le laboratoire de glaciologie et géophysique de l’environnement, Grenoble, France

Ongoing and projected changes in continental water cycle are closely connected to extreme events with specific mechanisms of water cycle changes. We are going to address observed variability and change in continental water cycle in the context of climate extremes. Although hydroclimate extremes result from many factors that sometimes act together, water is a central component of these extremes via either its excess or scarcity. The major factor underlying hydroclimate extremes is precipitation, closely associated with flooding and droughts resulting from long dry periods and substantial water deficits over large regions. Among the major problems of changes in water cycle associated with extremes we will consider changes in temporal structure of precipitation region (80–100km) from most of the European NDMC stations including spectro-photometers and imagers allow monitoring atmospheric variability at time scales comprising long–term trends, annual and seasonal variability, planetary and gravity waves and infrasonic signals. The measurements also allow validating satellite-based measurements such as from the TIMED-SABER instrument.

Examples will be presented for airglow measurements and for related atmospheric dynamics analysis on the abovementioned spatio–temporal scales and comparisons with satellite–based instruments as well as with LiDAR soundings. Focus will be on climate signals in the mesopause region.

K-1109-01

Connections between water and energy: Clouds, water vapour, radiation and precipitation

G. Stephens (1)

(1) JPL, California Institute of Technology, Pasadena, United States of America

Water and energy are intimately coupled together in the Earth’s climate system. Each controls the other. This talk will concentrate on atmospheric feedbacks that develop between water and energy that influence the global hydrological cycle response in a warming and moistening climate. As the planet warms, the amount the global precipitation increases is determined by the increased emission from the atmosphere that is mostly controlled by the increases to water vapor. The increases to water vapor, especially that transported to the upper atmosphere by convection, fundamentally affects the radiation balance both directly through the influence the clear–sky emission and by enhancing the absorption of radiation by the upper tropospheric clouds that develop as a consequence of the moistened upper troposphere. Thus feedbacks develop between radiation, clouds and precipitation that influence how the global hydrological cycle responds to a warmed climate. These feedbacks, and others will be discussed in the context of both global and regional changes to the hydrological cycle.

K-1109-02

Land processes and the global water cycle: Past results and upcoming CMIP6 plans

S. Seneviratne (1) ; B. Van Den Hurk (2) ; G. Krinner (3) ; H. Kim (4) ; C. Derksen (5) ; T. Oki (4)

(1) ETH, Zurich, Institute for atmospheric and climate sciences, Zürich, Switzerland; (2) KNMI, Model Development, De Bilt, Netherlands; (3) LGCE, Grenoble, France; (4) University of Tokyo, Global hydrology and water resources engineering, Tokyo, Japan; (5) Environment Canada, Climate research division, Toronto, Canada


K-1109-03

Changes in continental water cycle and extreme events

O. Zolina (1)

(1) Joseph Fourier University, Le laboratoire de glaciologie et géophysique de l’environnement, Grenoble, France

Ongoing and projected changes in continental water cycle are closely connected to extreme events with specific mechanisms of water cycle changes. We are going to address observed variability and change in continental water cycle in the context of climate extremes. Although hydroclimate extremes result from many factors that sometimes act together, water is a central component of these extremes via either its excess or scarcity. The major factor underlying hydroclimate extremes is precipitation, closely associated with flooding and droughts resulting from long dry periods and substantial water deficits over large regions. Among the major problems of changes in water cycle associated with extremes we will consider changes in temporal structure of precipitation region (80–100km) from most of the European NDMC stations including spectro-photometers and imagers allow monitoring atmospheric variability at time scales comprising long–term trends, annual and seasonal variability, planetary and gravity waves and infrasonic signals. The measurements also allow validating satellite-based measurements such as from the TIMED-SABER instrument.

Examples will be presented for airglow measurements and for related atmospheric dynamics analysis on the abovementioned spatio–temporal scales and comparisons with satellite–based instruments as well as with LiDAR soundings. Focus will be on climate signals in the mesopause region.
or precipitation timing. Over last several decades both wet and dry years have been observed in several European regions, specifically in Central and Eastern Europe. This effect is not associated with changes in the number of wet days but, rather, with the grouping of wet days into prolonged wet and dry periods, increasing the likelihood of floods and droughts, respectively. Another critical problem for accurate quantification of the impact of extremes on water cycle is scaling of precipitation. Representation of the impact of precipitation extremes on the water cycle strongly depends on spatial and temporal scales resolved by observational networks and models. With given resolutions we only partly capture the effect of extreme precipitation processes in hydrological cycles. It will be demonstrated potential of very dense observational networks for accurate estimation of the role of hydroclimate extremes in continental scale water cycle. We will also consider the role of oceanic feedbacks on moisture transport and extreme precipitation. Boreal summer Europe is a region of significant processes associated with midlatitude cyclogenesis. In this study, we will examine the role of atmospheric oceanic feedbacks on moisture transport and extreme precipitation. Finally, we will discuss the requirements for data characteristics and resolution for accurate estimation of the strongly localized nature of hydroclimate extremes and their impact on continental water cycle.

1109—POSTER PRESENTATIONS

P-1109-02

Typhoon Bopha: Impact of an extreme tropical cyclone on the atmospheric water and energy cycle.

T. Garot (1); H. Brongnies, (1); N. Viltard, (1)

(1) Laboratoire Atmosphère Millieux Observations Spatiales, Guyancourt, France

In a context of global warming, theory and modeling predict that hurricane intensity should increase with increasing global mean temperatures. It is therefore important to better study the extreme cyclones, which could become the average cyclones. Typhoon Bopha formed on November 25 and dissipated on December 9, 2012. It was the strongest tropical cyclone to ever hit the southern Philippine island of Mindanao, making landfall as a category 5 super typhoon. Typhoon Bopha caused substantial damage to Mindanao, leaving behind hundreds of thousands of homeless and more than 500 fatalities. During the life cycle of the typhoon, the Typhoon-35 unique satellite provided 2 to 5 sampling of the tropical atmosphere per day, thanks to its low inclination orbit (20°). At that time, the two microwave radiometers SAPHIR and MADRAS were both performing measurements, thus giving the opportunity to investigate:

(i) how the typhoon impacted the atmospheric humidity of its environment and (ii) the temporal evolution of its rain field. For this purpose, three different levels of upper tropospheric humidity retrieved from SAPHIR and MADRAS, rain rates and releases of total latent heat estimated from MADRAS were monitored along the storm track. We will discuss the mean behavior of the typhoon that shows strong lagged oscillations of the humidity and the convective activity and deepens its spatial asymmetries and their relationship with the nearby environment. This analysis was completed with the use of the tracking algorithm TOOCAN that allows to study how each individual convective clusters contributed to the life cycle of the typhoon.

P-1109-03

Cold/Shoulder Season Precipitation Near 0°C

P. Groisman (1); S. Gulev (2); O. Zolina (3); R. Vose (4); I. Hanssen-Bauer (5); O. Bulygina (6)

(1) UCar at NOAA National Climatic Data Center, Asheville, North Carolina, United States of America; (2) RAS P.P. Shirshov Institute for Oceanology, Moscow, Russia; (3) Joseph Fourier University, Le laboratoire de glaciologie et géophysique de l'environnement, Grenoble, France; (4) NOAA National Climatic Data Center, Asheville, North Carolina, United States of America; (5) Norwegian Meteorological Institute, Oslo, Norway; (6) Russian Inst. For Hydrometeorological Information, Obninsk, Russia

Small changes in atmospheric conditions lead to major changes in the types or amount of near−0°C precipitation. For example, if near−surface temperatures are slightly above−freezing inversion occurs or (or not) aloft, freezing rain (snow) can reach the surface. It also needs to be recognized that solid precipitation amounts near 0°C (such as wet snow) can be the highest in a winter storm.

With global climate change in the extratropics, the 0°C isotherm will not disperse and associated Typhoon/TC events will continue to occur. Rain should fall farther upslope in mountainous regions, thereby increasing the risk of flooding. Alterations in temperatures, storm intensity and cloud structure will add to the frequency and occurrence of near−0°C precipitation including freezing rain. Weakening of the atmospheric circulation in the extratropical regions may lead to more polar jet stream meandering that can lead to more persistent near 0°C events. The overall warming, together with a larger influx
of the water vapour in the winter atmosphere from the oceans (including ice-free portions of the Arctic Ocean) will allow more water vapour in the winter atmosphere that can increase the amount of near-0°C precipitation. And, near-0°C temperatures should generally move poleward and arrive at many locations earlier in spring or later in autumn. This could potentially affect the seasonal cycle of near-0°C precipitation.

Despite significant progress in addressing near-0°C precipitation, it remains a challenging issue. Kunkel et al. (2013; Bull. Amer. Meteorol. Soc.) indicated that freezing precipitation was associated with the lowest level of understanding for both detection and attribution amongst several types of hazardous weather conditions affecting the U.S.

The overall issue of near 0°C precipitation is linked with several phenomena. These include blizzards (just snow), rain-on-snow (both phases with a particularly importance of observed precipitation interaction with pre-existing snowpack), freezing rain and drizzle (just liquid). The specific hazards associated with these events include: Heavy snowfall/rainfall transition around 0°C; Blizzards, rain-on-snow events; Freezing rain and freezing drizzle, and Ice load on infrastructure.

Our presentation will overview what we know and what we do not know about these phenomena, and formulate major tasks to advance in understanding of near-0°C precipitation, its changes, and impact.

P-1109-04
Current and future changes in precipitation and its extremes across wet and dry regions

CL. Liu (1) ; R. Allan (1)
(1) Department of Meteorology, University of Reading, Reading, United Kingdom

Global warming is expected to enhance fluxes of fresh water between the surface and atmosphere, causing wet years to become wetter and dry years drier, with serious implications for water resource management. Defining wet and dry regions as the upper 30% and lower 70% of the precipitation totals across the tropics (30oS–30oN), each month we combine observations and climate model simulations to understand changes in the wet and dry extremes over the period 1850–2100.

Observed decreases in precipitation over the driest tropical land (1950-2010) are also simulated by coupled atmosphere-ocean climate models (~0.3%/decade) with trends projected to continue into the 21st century. Discrepancies between observations and simulations over the wettest land regions since 1950 are explained by decadal fluctuations in El Niño southern oscillation, the timing of which is not represented by the coupled simulations. Changes to atmosphere-only simulations are instead driven by observed sea surface temperature they are able to adequately represent this variability over land.

By considering changes in the intensity distribution of precipitation, we find that global distributions of precipitation trends are dominated by spatial changes in atmospheric circulation. Unforced variability appears to explain discrepancies between observations and model simulations of the wettest land regions, while regional feedbacks and secular changes in atmospheric circulation patterns become increasingly important in the future. Projected increases in extreme precipitation with warming over land are not diagnosed for the present day due to these dynamical influences which indicate that natural variability over land is not a good proxy for future climate change.

Nevertheless, the tendency for the wettest part of the tropical circulation to become wetter (precipitation increases with warming by ~3%/K over wettest land grid points) and the driest part of the atmospheric circulation to become drier (precipitation decreases of ~2%/K over the driest tropical land grid points) is a robust result that emerges over the 21st century in response to the substantial surface warming. This indicates that enhancement in seasonality and wet and dry extremes (flooding and drought) may be anticipated over the coming century.

P-1109-05
Assessment of climate transformation in Belarus according to the COSMO-CLM model simulations

I. Partasenok (1) ; B. Geyer (2) ; V. Melnik (1)
(1) Hydromet, Minsk, Belarus; (2) Institute of Coastal Research, System analysis and modelling, Geesthacht, Germany

According to climatic investigations deviations of annual temperature have increased during last decades in Belarus. The period of significant transformation of the temperature regime has been observed since 1970s, and rapidly since 1989.

We used simulations of the COSMO model in CLimate Mode (COSMO–CLM or CCLM) for detailed assessment of climate transformation in Belarus. This is a nonhydrostatic regional climate model developed from the Local Model (LAM) of the German Meteorological Service by the CLM-community.

The coastDatll dataset was produced with the COSMO–CLM at the Institute of Coastal Research of HZG to give a consistent and homogeneous database mainly for assessing weather statistics and climate changes since 1946, e.g., in frequencies of extremes for Europe. The simulations were done for 1948 to 2012 and a horizontal grid size of 0.22 degree in rotated coordinates. Global reanalysis data of NCEP1 were used as forcing.

The observed gridded data (E-Obs) was applied in the study for estimation of adequacy of the model simulations. We used the E-Obs v.10.0 gridded dataset (European Climate Assessment & Dataset) for the period of 1950-2012 as an European daily high-resolution gridded dataset the surface temperature and precipitation data.

We calculated means of seasonal temperature and precipitation over Belarus for 1955–2012 period. The calculations of temperature showed differences in the coastDatll and E-Obs varied within 0.6–2 oC depending on season. The largest deviations were obtained in winter and consist of 1.7–2.0 oC, in spring differences were as 0.5–1 oC; in summer were obtained the smallest deviations within 0.6–0.8 oC and in autumn they were about 1.0–1.3 oC. Yearly means differ for both period on 0.9 oC. During the year the E-Obs values were higher than coastDatll except summer when values derived from CCLM exceed the observed ones. Analysis of min/max values of seasonal temperature proved smoothed course of the temperature with less amplitude in CCLM.

Calculated differences of annual sums of precipitation were not significant and lied within 7%. But differences of seasonal sums varied from 10 to 20 %, especially in summer season when difference was about 50 %. It could be explained as an incorrect calculation of precipitation forced by convective process.

Analysis of annual temperature trends according to coastDatll showed statistically significant increasing of temperature over entire territory of Belarus: from 0.2–0.7 oC per decade on the West to 0.3 oC per decade of the East of the country. Trends of annual precipitation showed remarkable increasing (up to 0.15 mm per decade) in the North and North-East part of the Belarus but in the central and southern parts of the country sums of annual precipitation varied within norm.

P-1109-06
Physical properties and evolution of mesoscale high cloud systems

S. Protopapadaki (1) ; C. Stubenrauch (1) ; A. Feofilov (1)
(1) Laboratoire de Météorologie Dynamique, Université de Paris 6, Paris, France

Representing about 40% of the Earth’s total cloud cover, clouds in the upper troposphere play a crucial role in the climate system by modulating the Earth’s energy budget and heat transport. These clouds often form mesoscale cloud systems extending over several hundred kilometres. Ubiquitous cirrus (semi-transparent ice clouds in the upper troposphere) evolve as the outflow of convective and frontal systems or form in cold air supersaturated
with water. Both their evolution with climate change and their feedback can only be reliably estimated if these cloud systems are adequately represented in climate models. Only satellite instruments are able to give a picture as a whole of these systems. IR sounders are observing only planetary-scale fields since 1979, with improvements in spectral resolution: from the TIROS-N Operational Vertical Sounder (TOVS) onboard the NOAA polar satellites through the Atmospheric Infrared Sounder (AIRS) onboard Aqua since 2002, and to the Infrared Atmospheric Sounding Interferometer (IASI) on board the MetOp platforms since 2006. The good spectral resolution of these instruments allows reliable cirrus identification, both from day and night-time observations. For this study we have developed a novel method to describe mesoscale high cloud systems, taking into account their horizontal extent. The occurrence of convection within these systems will be estimated by using cloud emissivity and a clustering method. This allows a distinction between in situ cirrus and cirrus linked to convective or frontal systems. The vertical extent of these cloud systems, essential for determining the energy balance at the Earth surface, can only be determined from active instruments (CALIPSO lidar and CloudSat radar synchronous with AIRS). This data set will be explored and distributed within the framework of the GEWEX Process Evaluation Study on Upper Tropospheric Clouds and Convection (UTCC PROES).

We will relate the horizontal extent of the anvil to the convective strength of the system and we will present first results on the variability of high cloud systems with their surrounding atmosphere. Analyzing the evolution and properties of mesoscale cloud systems as a whole and their role in generating cirrus clouds will be a major advancement in climate studies, also giving a new impulse in climate model evaluation.

P-1109-07
Long-term changes in snowfall over Japan and its regionality
H. Takahashi (1); S. Sugimoto (1)
(1) Tokyo Metropolitan University, Tokyo, Japan

We examined the long-term changes in snowfall over Japan for recent 50 years, using observational data and a regional climate model.

Climate change can significantly influence the snowfall on the Japan Sea side of Japan because the seasonal surface air temperature is higher than 0 deg C in northern winter. This side of Japan is one of the heaviest snowfall regions on Earth. These heavy snowfalls are a consequence of the northwestern flow of the Asian winter monsoon from Eurasia and the region's windward (northwestern side) position along Japan's northeast-southwest trending central mountain range. Two main factors influence precipitation over the Japan Sea side. One is the activity of cold and dry northwesterly winds of the Asian winter monsoon, and the other is sensible and latent heat fluxes on the Japan Sea, which are strongly associated with the sea surface temperature (SST).

The snowfall amount can be influenced by total precipitation amount and ratio of snowfall amount to the total precipitation. Total precipitation is modulated by many factors. On the other hand, the ratio of snowfall amount to the total precipitation is basically due to surface air temperature. Thus, we investigated the both factors, focusing on regional difference of the long-term changes.

Results showed that snowfall has drastically changed over the Sea of Japan side of Japan around late 1980's. Concurrent with the drastic change in snowfall, surface air temperature has dramatically increased. However, the drift in changes was variable among different regions, which was modulated by the total precipitation changes. The regionality of long-term changes in snowfall will be discussed.

P-1109-08
Analysis of freezing rain occurrence over Eastern Canada using regional climate model simulations
J. Thériault (1); É. Bresson (2); M. Chollette (1); D. Paquin (2); R. Laprise (1); R. De Elía (2)
(1) Université du Québec, Earth and Atmospheric sciences, Montréal, Canada; (2) Ouranos, Montreal, Canada

Winter storms can lead to many types of precipitation at the surface when the temperature is around 0°C. Freezing rain is the most damaging precipitation type produced during these storms. Its occurrence is associated with favourable synoptic conditions, leading to a temperature inversion associated with temperatures >0°C aloft and subfreezing temperature near the surface. The overall goal of this study is to investigate the changes in the occurrence of freezing rain with our changing climate using regional climate model outputs. In particular, a study of the occurrence of freezing rain is conducted with climate simulations produced by the Canadian Regional Climate Model 5 (CRCM5) over Eastern Canada. This is achieved using existing empirical techniques commonly used to solve for the various winter precipitation types produced during storms. These techniques are based on the vertical temperature structure that affects strongly the type of precipitation reaching the surface. The results show that the model resolution impacts the vertical temperature structure. The suggested model resolution will impact the production of freezing rain by the model. Hence, the differences in the freezing rain occurrence diagnosed at different model resolutions are summarized. Overall, this study shows additional regional climate models can account of winter precipitation types to assess how their occurrences will evolve in our changing climate.

K-1110-01
Climate and Ocean: past, current and future changes and variability - a challenge for observations, models and assessment
M. Visbeck (1)
(1) GEOMAR & Kiel University, Kiel, Germany

The ocean covers more than 70% of the surface of our planet and plays a key role in supporting life on Earth. It hosts the most diverse and important ecosystems, and contributes to the global and regional elemental cycling. The ocean regulates our climate, and through climate, habitats are shaped that allowed humans to thrive and develop our societies. The marine system provides us with natural resources such as food, materials, substances, and energy. Furthermore, the oceans and the regional seas are essential for international trade, recreational and cultural activities.

A growing world population with increasing levels of affluence has had a noticeable impact on the environment causing ‘global change’. In the area of climate in particular increasing levels of greenhouse gas emissions have altered the planetary heat balance and caused changes in both global and regional climate.

The Intergovernmental Panel for Climate Change (IPCC) most recent assessment reminds us that: "The ocean's heat capacity is about 1,000 times larger than that of the atmosphere, and the oceans net heat uptake since 1960 is around 20 times greater than that of the atmosphere." About 90% of this extra heat has been stored in the ocean. The ocean plays a crucial role in climate change, in particular in variations on seasonal to decadal time scales. One example is sea level: the addition of heat and freshwater flux from the melting glaciers and ice sheets have cause the sea level to rise. The latest IPCC gives a best estimate rate for 1961 to 2003 as 1.8 ± 0.5 mm yr-1. However, the regional differences are large and the interplay between natural climate and ocean variability and change remains a challenge for assessments.
Finally, the IPCC addresses the adequacy of ocean observing systems. “Many ocean observations are poorly sampled in space and time, and regional distributions often are quite heterogeneous. Furthermore, the observational records only cover a relatively short period of time (e.g., the 1950s to the present). Many of the observed changes have significant decadal variability associated with them, and in some cases decadal variability and/or poor sampling may prevent detection of long-term trends. When time series of ocean observations are considered as a whole, they are often computed in order to quantify the observed long-term changes; however, this does not imply that the original signal is best represented by a linear increase in time.” Thus the IPCC notes for the global ocean observing community to rise to the challenge and deliver a fit-for-purpose more integrated, more cost effective and more sustained ocean observing system.

**K-1110-02**

How do we observe and model the changing ocean physics, biogeochemistry, and ecosystems?

N. Pinardi (1)

(1) University of Bologna, Department of Physics and Astronomy, Bologna, Italy

The oceans play a crucial role as a climate regulator, and changes in ocean physics, biogeochemistry, and biology have direct impact on human well-being through hazards and ecosystem services changes.

Long-term, globally-coordinated, and high-quality sustained ocean observations are required to understand and model the role of the ocean in the earth’s climate, to monitor ocean change, and to provide initial conditions to predict the evolution of climate on scales including seasonal, decadal, and centennial. Building on national efforts, these observations are internationally coordinated through the Global Ocean Observing System and the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology, building on the processes of a common Framework for Ocean Observing devised and adopted by the ocean observing community.

Observations and models combine to provide the best possible estimates of the present and future state of the ocean. These observations and forecasts inform decision-making about coastal protection, the marine economy, long-term changes in patterns of drought and flood, and the human consequences linked to climate change. Our confidence in the observations and models has increased over time, even as some key critical knowledge gaps remain.

**O-1110-01**

Pacific western boundary currents and their roles in climate

A. Ganachaud (1); D. Hu, (2); L. Wu, (3); W. Cai (4); G. Sen (5); B. Qiu, (6); A. Gordon, (7); X. Lin, (5); Z. Chen, (3); S. Hu, (2); G. W. Skerlj, (8); Q. Wang, (2); J. Sprintall, (9); T. Q. (10); Y. Kashino, (11); F. Wang, (2); W. Kessler, (12); A. Melet (13)

(1) IRD/LEGS, Toulouse, France; (2) Institute of Oceanology, CAS, Key laboratory of ocean circulation and waves, Qingdao, China; (3) Qingdao Collaborative Innovation Center of Marine Science and Technology, QMUC, Physical oceanography laboratory, Qingdao, China; (4) CSIRO, Melbourne, Australia; (5) The University of New South Wales, Australian research council (arc) centre of excellence for climate system science, Sydney, Australia; (6) University of Hawaii at Manoa, Department of oceanography, Honolulu, United States of America; (7) Lamont-Doherty Earth Observatory, Earth Institute, Columbia University, Palisades, New York, United States of America; (8) CSIRO, Marine and atmospheric research, Melbourne, Australia; (9) Scripps Institution of Oceanography, La Jolla, United States of America; (10) School of Oceanography, University of Washington, Seattle, United States of America; (11) Japan Agency for Marine– Earth Science and Technology (JAMSTEC), Center for earth information science and technology, Kanagawa, Japan; (12) NOAA, Pacific marine environmental laboratory, Seattle, United States of America; (13) CNES/LEGS, Toulouse, France

Pacific Ocean western boundary currents and the interlinked equatorial Pacific circulation system were among the first to be explored by pioneering oceanographers. The widely accepted but poorly quantified importance of these currents – in processes such as the El Niño-Southern Oscillation, Pacific Decadal Oscillation and Indonesian Throughflow – has triggered renewed interest, with ongoing efforts seeking to understand the balances of the equatorial Pacific, and possible changes associated with greenhouse–induced climate change. Only a concerted international effort through WCRP/CLIVAR will enable us to achieve the observational, theoretical and technical gaps currently limiting a robust answer to these elusive questions. This work will present a review of the boundary current characteristics, variations and their effects on local and remote climate, as well as their future projections.

**O-1110-02**

Preliminary results from the international South Atlantic Meridional Overturning Circulation (SAMOC) Initiative

S. Speich (1); S. Garzoli (2); A. Piola (3); E. Campos (4)

(1) Ecole normale supérieure, Département de geosciences, paris, France; (2) NOAA, Aoml - phod, Miami, United States of America; (3) Servicio de Hidrografía Naval, Buenos Aires, Argentina; (4) Universidad de Sao Paulo, Instituto oceanográfico, Sao Paulo, Brazil

Within the MOC, the South Atlantic Ocean plays a key role as a nexus for water masses formed elsewhere and as a route to remote regions of the global ocean. Because of this important interbasin exchanges, the South Atlantic Ocean is the only major ocean basin that transports heat from the pole towards the equator. However, the South Atlantic is not merely a passive conduit for remotely formed water masses. Indeed, within this basin water masses are significantly altered by local air–sea interactions and diapycnal/isopycnal fluxes, particularly in regions of intense mesoscale activity and steep topography. These contributions have been shown to have a crucial role in the strength of the MOC in paleoceanographic and modelling studies.

The monitoring of the North Atlantic portion of the MOC has been ongoing for a decade now through the RAPID/ MOC/WBTS program as well as other national and international initiatives. They all provide a scope for understanding the MOC variability in that region. Given the complex, multibasin nature of the MOC, achieving a more complete understanding of its behaviour and changes requires a more comprehensive observing system, one that extends across neighbouring ocean basins as the one we are developing for the South Atlantic within the CLIVAR SAMOC initiative.

In this presentation, we will discuss the preliminary results on estimates of the daily MOC strength at 35°S during a 20 month long pilot array of mooring as well as model outputs and Argo data. The MOC variability show to be as large as that at 26N, with both eastern and western boundary flows contributing equally to the variance.

The full array was re-established in the fall of 2013 in collaboration with France, Brazil, Argentina and South Africa.

**O-1110-03**

Exceptional 20th-Century slowdown in Atlantic Ocean overturning circulation

S. Rahmstorf (1); J. Box, (2); G. Feulner, (1); M. Mann, (3); A. Robinson, (4); S. Rutherford, (5); E. Schafnertlich, (1)

(1) Potsdam Institute for Climate Impact Research, Potsdam, Germany; (2) Geological Survey of Denmark and Greenland (GEUS), Copenhagen, Denmark; (3) Potsdam Institute for Climate Impact Research, University, University Park, United States of America; (4) Universidad Complutense de Madrid, Madrid, Spain; (5) Roger Williams University, Bristol, United States of America

Possible changes in Atlantic meridional overturning circulation (AMOC) provide a key source of uncertainty regarding future climate change. Maps of temperature trends over the twentieth century, particularly on the high latitude region of cooling in the northern Atlantic. Here we present multiple lines of evidence suggesting that this cooling may be due to a reduction in the AMOC over the twentieth century and particularly after 1970. Since 1990 the AMOC seems to have partly recovered. This time evolution is
consistently suggested by an AMOC index based on sea surface temperatures, by the hemispheric temperature difference, by coral–based proxies and by oceanic measurements. We discuss a possible contribution of the melting of the Greenland Ice Sheet to the slowdown. Using a model to reproject the historical reconstruction for the AMOC index suggests that the AMOC weakness after 1975 is an unprecedented event in the past millennium (p > 0.99). Further melting of Greenland in the coming decades could contribute to further weakening of the AMOC.


**Variability of the Meridional Overturning Circulation observed since 1993 across the A25-OVIDE section in the North Atlantic subpolar gyre, and its impact on the CO2 physical pump**

P. Lherminier (1) ; N. Daniault, (2) ; FF. Perez, (3) ; P. Zunino, (1) ; H. Mercier (4) ; A. Sarafanov, (5) ; F. Gaillard (1) ; P. Morin (6) ; AF. Riis (3) ; D. Desbruyères (7) ; A. Fallina (5) ; B. Ferron (4) ; T. Huck (8) ; V. Thierry (1) ; M. García-Ibáñez (3) ; M. P. Sinha (9) ; Y. T. Marshall (10) ; M. Woldeab (11) ; P. H. Sherwood (12) ; P. M. Pinheiro (13) ; A. García-Oliveira (14) ; F. Alves (15) ; N. Leblond (12) ; A. Schleshy (13) ; J. Quispe (14) ; J. Sudre (2)

(1) LNE, Laboratoire de Physique des Océans, BREST, France; (2) UPMC, Université Paris 6, Laboratoire d’Océanographie Physique, BREST, France; (3) Instituto Investigaciones Marinas (CISC), Departamento de Oceanografía, VIGO, Spain; (4) CNRS, Laboratoire de physique des océans, BREST, France; (5) P.P. Shirshov Institute of Oceanology, Moscow, Russia; (6) IPEV, Scientific direction, PLOUZANE, France; (7) National Oceanography Centre, Southampton, United Kingdom; (8) CNRS, Laboratoire de physique des océans, Brest, France

The meridional overturning circulation (MOC) transports heat from the subtropics to high latitudes and hence plays an important role in the Earth’s climate. A region crucial for the MOC is the northern North Atlantic and the adjacent Nordic Seas, where waters transported northwards in the MOC progressively gain density and eventually sink into the southward flowing lower limb. Here we will discuss the variability of the subpolar gyre circulation, the MOC and heat transport as quantified from a joint analysis of hydrographic and velocity data from eight repeats of the Greenland to Portugal OVIDE section (1997–2014), satellite altimetry and ARGO float measurements. For each repeat of the OVIDE section, the full-depth absolute circulation and transports were measured using a inverse model constrained by shipboard Acoustic Doppler Current Profiler data and by an overall mass balance. The obtained circulation patterns revealed a very well reproducible transport across the whole column and evidenced large variations (up to 50% of the lowest value) in the magnitude of the MOC computed in density coordinates (MOCσ). The extent and timescales of the variability of the MOCσ are freely evaluated using a monthly MOCσ index built upon altimetry and ARGO data at the OVIDE section location. The MOCσ index, validated by the good agreement with the estimates from repeat hydrographic surveys, shows a large variability on monthly to decadal time scales, with an interannual variability from less than 15 Sv to about 25 Sv (1 Sv = 1,000,000 m³ s⁻¹). The heat transport estimated from these observations varies by a factor of 2 over the timescales of 0.29 and 0.70 ± 0.05 PW and is linearly related to the MOCσ intensity.

The uptake of atmospheric carbon dioxide in the subpolar North Atlantic Ocean declined rapidly between 1990 and 2006. This reduction in CO2 uptake was related to warming at the sea surface, which—according to model simulations—was associated with a reduction in the AMOC. Here, we use the observed oceanic transport of volume, heat and carbon dioxide to track the CO2 uptake in the subtropical and subpolar regions of the North Atlantic Ocean over the past two decades. We separate anthropogenic carbon—derived from human activities—from natural carbon by assuming that the latter cannot cross the respiratory barrier, sulfidic events) at both local and global scales. The objective of the AMOP project (“Activities of research dedicated to the Minimum of Oxygen in the eastern Pacific”) is to provide an estimate of physical and biological processes contributing to the O2 budget off Peru. The central hypothesis is that the physical and biogeochemical O2 contribution to the OMZ maintaining oxygen dynamics at both local and global scales. The objective of the AMOP project (“Activities of research dedicated to the Minimum of Oxygen in the eastern Pacific”) is to provide an estimate of physical and biological processes contributing to the O2 budget off Peru. The central hypothesis is that the physical and biogeochemical O2 contribution to the OMZ maintaining oxygen dynamics at both local and global scales. The objective of the AMOP project (“Activities of research dedicated to the Minimum of Oxygen in the eastern Pacific”) is to provide an estimate of physical and biological processes contributing to the O2 budget off Peru. The central hypothesis is that the physical and biogeochemical O2 contribution to the OMZ maintaining oxygen dynamics at both local and global scales.

**Oxygen Minimum Zone (OMZ) dynamics in the context of the ocean deoxygenation: the case off Peru from the AMOP «Activity of research dedicated to the Minimum of Oxygen in the eastern Pacific» project**

A. Paulmier (1) ; B. Dewitte (2) ; C. Maes (3) ; M. Bretagnon (2) ; V. Garçon (4) ; F. Campos (5) ; FG. Augusto (6) ; K. Mosquera (7) ; O. Vergara (2) ; C. Barus (2) ; L. Coppola (8) ; O. Debretz-Degenicourt (9) ; E. Garcia-Robledo (10) ; J. Graet (11) ; S. Illig (2) ; I. Montes (7) ; N. Leblond (12) ; A. Moschle (13) ; J. Quispe (14) ; J. Sudre (2)

(1) LEGOS, SYSCO2 team, TOULOUSE, France; (2) LEGOS, Toulouse, France; (3) IRD-CNRS-Ifremer-UBO, LABORATOIRE DE PHYSIQUE DES OCÉANS, BREST, FRANCE; (4) POM, Laboratoire de Physique des Océans, BREST, FRANCE; (5) UNAM, CALLAO, Peru; (6) UPG, LIMA, Peru; (7) IGP, LIMA, Peru; (8) OOV, VILFRENCHE/S/MER, France; (9) Parc Instrumental DT-INSU/CNRS, PLOUZANE, France; (10) University of Aarhus, AHAHRUS, Denmark; (11) US IMAGO, PLOUZANE, France; (12) CNRS, Lov, Villefranche sur mer, France; (13) GEOMAR, Kiel, Germany; (14) IMARPE, CALLAO, Peru

Oxygen Minimum Zones (OMZs), defined as suboxic (O2<20 µmol/L) subsurface layer and mainly associated with Eastern Boundary Upwelling Systems (EBUS), would contract and expand during cold and warming periods, respectively. In the current context of the ocean deoxygenation, OMZs are known to play a key-role on the evolution of climate (greenhouse gases) and on the ecosystems and fisheries (nitrogen loss, respiratory barrier, sulfidic events) at both local and global scales. The objective of the AMOP project (“Activities of research dedicated to the Minimum of Oxygen in the eastern Pacific”) is to provide an estimate of physical and biological processes contributing to the O2 budget off Peru. The central hypothesis is that the physical and biogeochemical O2 contribution to the OMZ maintaining oxygen dynamics at both local and global scales. The objective of the AMOP project (“Activities of research dedicated to the Minimum of Oxygen in the eastern Pacific”) is to provide an estimate of physical and biological processes contributing to the O2 budget off Peru.
participants) is viewed as one of the main pilot projects of the SOLAS My Current Upwelling System (OMZ-EBU). In this presentation, preliminary results of the project will be presented both on observations and modeling, illustrating current challenges for the investigation of OMZ dynamics in Eastern Boundary current systems.

**P-1110-01**

Recent changes and trends of the upwelling intensity in the Canary Current Upwelling System

A. Benazzouz (1); K. Hilmi (2)

(1) Institut National de Recherche Halieutique, Département océanographie, Casablanca, Morocco; (2) Institut National de Recherche Halieutique, Département océanographie, Casablanca, Morocco

A summary of current knowledge for the quantification of the upwelling intensity from wind and SST is provided on the Canary Current Upwelling System (8°N-43°N) from 1982 to 2011. Statistical analysis of trends and seasonal changes of the upwelling activity are carried out in this work. Linear trends in upwelling intensity are estimated from both atmospheric forcings (wind stress and oceanic response (SST), both derived from satellite data, with a particular focus on the Cap Chir of the moroccan area (30.5°N). The results indicate different spatial trends in the upwelling favorable winds and an apparent increasing coastal warming associated with intensification of winds at the regional scale off Northwest Africa is found.

**P-1110-02**

Long term marine time-series expose underlying climate-driven changes in South America during the last 40 years

A. Arias (1); E. Alberdi, (2); R. Freije, (3); J. Marcovechio, (4)

(1) Argentine Institute of Oceanography (IAIDO), CONICET, Bahia Blanca, Argentina; (2) Argentine Institute of Oceanography (IAIDO), CONICET, Bahia Blanca, Argentina; (3) Universidad Nacional del Sur, Chemistry, Bahia Blanca, Argentina

Climate Change is creating a dynamic of continuous changes in ecosystems. Generally, the expected consequences of climate change on marine ecosystems are usually local or regional phenomena. One of the keys to uncover climate-driven changes are the long-term time-series of observations. While there are a number of long-term biological time-series on land, there are relatively few in marine environments. This is highlighted by the fact that the Intergovernmental Panel on Climate Change (IPCC) noted 28586 significant biological changes in terrestrial systems, but only 85 from marine and freshwater systems. The present research deals with this gap in the state of the art, focusing in an area which holds scarce to null long-term research on ocean observation and climate driven changes: the South Atlantic Ocean. From the results of the analysis of up to 40 years of oceanographic physicochemical variables measured at the Bahia Blanca Estuary (Dissolved Oxygen, pH, Chlorophyll, Phaeopigments, Temperature, Salinity, NH4, Particulate Organic Matter, NO2, NO3, Phosphorous, etc.) unknown underlying trends were uncovered. In order to test the variables trend throughout several time-scales, the continuous wavelet transform (CWT) was used to divide the continuous–time function into wavelets. Moreover, the use of Cross-Wavelet Correlation (CWC) allowed to light the relationship between the variables throughout different time-scales. After that, a correlation analysis which linked the ocean observations to biological documented changes with associated trends were assessed. As result, novel hypotheses were raised in the field of phytoplankton and zooplankton assemblages climate–driven control, crustaceans catches and fisheries recruitment. For instance:

- "climate–driven variations in ocean Temperature, pH, DO and Salinity can restrict the growth of the phytoplankton assemblages, leading to other factors (i.e., grazing) the size control of the cells".

- "low interannual variability of water temperature and water salinity favours higher fishing yields and vice versa”

Undoubtedly, these findings will strengthen the theory which propose climate-driven changes at marine coastal ecosystems as a consequence of global climate change and will be of high relevance for the international dialogue on “anthropogenic vs. climate–induced changes” over the oceanic ecosystems.

**P-1110-03**

Past and future seasonal changes in Sea Surface Temperature in the Western English Channel as derived from satellite data and CMIP5 multimodel ensemble

B. L’hévéder (1); S. Speich (2); F. Gohin (3)

(1) CNRS, LMD, Paris, France; (2) Ecolne normale superieure, Département de geosciences, paris, France; (3) Ifremer, Dyneco/pelagos, Brest, France

Seasonal changes in Sea Surface Temperature (SST) in the Western English Channel are estimated for the last decades from high-resolution satellite data, obtained by concatenating Ifremer AVHRRsst, OSTIA and ODYSSSEA data over 1986–2013. Coastal seas, well separated from offshore waters by intense frontal structures, present colder SST by about 1°C in the English Channel to 2°C in the Iroise Sea in summer. A significant warming trend, concentrated in the autumn season, is highlighted. It is stronger offshore, with a SST annual mean increase of 0.32°C/decade, while it amounts to 0.23°C/decade in coastal waters where a strong vertical mixing induced by tides and wind acts to reduce surface warming.

The performance of an ensemble of global climate models, participating in the Coupled Model Intercomparison Project Phase 5 (CMIP5), in simulating recent seasonal changes of SST in the region is estimated. The median of CMIP5 models reproduces very well the observed SST seasonal cycle in offshore seas, but is less proficient in coastal waters due to model coarse resolution and absence of tidal forcing and related processes. In the Iroise Sea, the trend of the annual mean SST is relatively well simulated, albeit somewhat underestimated (0.20°C/decade) and evenly distributed throughout the year.

The regional values of the annual mean SST as generated by the CMIP5 future scenarios simulations, range from 0.5°C (RCP2.6) to 2.5°C (RCP8.5) by year 2100, with a seasonal modulation leading to a more intense warming in summer than in winter. This increase in SST may strongly affect marine life forms, like the evolution of the main marine alga population density and phenology in the Western English Channel.

**P-1110-04**

Comparing coastal and open ocean sea level variability and trend from altimetric data

A. Melet (1); F. Birol, (2); B. Meysignac (2)

(1) CNES/LEGOS, Toulouse, France; (2) LEGOS, Toulouse, France

Since 1993, altimetry has provided an unprecedented opportunity to study sea level variability with a quasi-global coverage. Satellite altimetry was one of the first tools to measure sea level rise because of its ability to estimate sea level rise from repeated satellite tracks. Since 1993, altimetry has provide the opportunity to study sea level rise from repeated satellite tracks. Recently, along-track altimetric data have been reprocessed at LEGOS/CTON using algorithms adapted to coastal regions to recover information on coastal zones (this reprocessed coastal product is referred to as the XTRACK dataset here).

In this study, we first recalibrate the along-track Topex–Poseidon, Jason–1 and Jason–2 XTRACK dataset to that distributed by AVISO to have consistent sea level data in the open ocean. Then, sea level trends are computed with the XTRACK dataset to analyse how sea level rise varies as a function of the distance to the coast. Spectral analyses are performed to assess the frequency bands for which
coastal sea level variability and open ocean variability differ. Analyses are performed over two regions (West coast of Africa and southwest Pacific). They will be extended to the entire period of sea level trends over the 1993–2012 period for the coastal zones of the global ocean.

P-1110-05
Ocean regulation of atmospheric carbon dioxide: timing of atmosphere-ocean reorganization, and CO2 outgassing during last deglaciation

E. Michel (1); G. Siani, (2); A. Mazaud (1); P. P. Van (3); M. Paterne (4); N. Haddam, (1); S. Jaccard, (5); G. Isguder (2); T. Devolle (1); T. Devols, (6); E. Michel (1); G. Isguder (E. Michel) (2); A. Mazaud (1); DPN. Van (3); G. Siani, (2); A. Mazaud (1); and C. Verbruggen, (7); S. Bjorck, (3); C. Waelbroeck (8); R. Depol-Holz, (9); C. Kissel, (1)

(1) CEAM (CRSUV, LSEI–IPSL), Gif-sur Yvette, France; (2) Université Paris–Sud, Orsay, France; (3) GCEPS, Université Orsay Paris–Sud, Orsay, France; (4) Quaternary Sciences, Department of geology, Lund, Sweden; (5) Laboratoire des Sciences du Climat et de l’Environnement (LSEI–IPSL), CEA–CRSUV–LSEI–IPSL, Gif–surYvette, France; (6) Instituto de Gestión del Suelo y el Medio Ambiente (IGSMA, CSIC), Madrid, Spain; (7) Laboratoire des Sciences du Climat et de l’Environnement (LSEI–IPSL), Gif–surYvette, France; (8) Department of Oceanography, Universidad de Concepción, Concepción, Chile

During the last deglaciation, centennial to millennial scale large climate changes occurred with a climate decoupling between the North and South poles called the bipolar seesaw. These events, expression of the complex interaction between the ocean, the atmosphere, and the cryosphere, are not well understood yet. Associated with these events, CO2 outgassing from the ocean to the atmosphere can be observed. These increases in atmospheric CO2, preceding the Earth’s global temperature increase, have been an important factor of the deglaciation. In the Southern Ocean, the sea-to-air interaction is particularly strong due to the role of the Southern Ocean in the CO2 cycle, and its role as a sink of atmospheric CO2. In this study, we present high-resolution records from the Southern Ocean to constrain the role of the Southern Ocean in the atmosphere-ocean carbon cycle during the last deglaciation.

P-1110-06
Interannual variability of upper ocean stratification in Bay of Bengal: observational and modeling aspects

F. S. T (1); P. Anant (2); C. Gnanaseelan, (2)

(1) INDIAN INSTITUTE OF TROPICAL METEOROLOGY, T. D DIVISION, PUNE MAHARASHTRA, India; (2) Indian Institute of Tropical Meteorology, T. D. Division, Pune, India

The annual cycle and interannual variability of stratification in Bay of Bengal (BoB) are studied using both observational and Global Ocean Data Assimilation System (GODAS) analysis during 2003–2012. Annual cycle of stratification and SST evolves coherently (correlation coefficient is 0.85) highlighting its role on modulating air-sea interaction over this climatically important region. Spatial distribution of stratification shows strong seasonality in ARGO observations, whereas it is highly underestimated in GODAS with higher discrepancies during fall and spring. The annual cycle of SSS in GODAS is out of phase with observations implying possible potential feedbacks. During the early part of winter and fall, stratification is lower than that reported during the El Niño years. All these features are misrepresented in GODAS. As stratification modulates air-sea interaction over BoB especially during El Niño and La Niña years, such misrepresentation of ocean stratification may lead to improper thermocline–SST coupling in the models. The mean stratification and its interannual variability in GODAS are weaker than observed events. Through interannual variability, a strong role of wind in determining stratification is highlighted. In GODAS, a proper representation of mixing for the deeper penetration of surface warm and freshwater resulting weaker stratification. As GODAS is used to initialize the ocean model of the Coupled Forecasting System (CFS) for seasonal prediction, a proper representation of mixing is essential. This study advocates the need of accurate representation of mixing in GODAS for improved summer monsoon forecast.

P-1110-07
Methane distributions and sea-to-air fluxes in the South China Sea and the West Philippine Sea

H.C. Tseng (1); CTA. Chen, (2); AV. Borges, (3); TA. Delvalls, (1)

(1) University of Cadiz, Physical Chemistry Department, Cadiz, Spain; (2) National Sun Yat–sen University, Department of oceanography, Kaohsiung, Taiwan; (3) University of Liege, Unité d’océanographie chimique, Liege, Belgium

We collected 700 water samples in the South China Sea (SCS) and 300 water samples in the West Philippines Sea (WPS), during 8 cruises from August 2003 to July 2007 in order to determine methane (CH4) distributions from surface to depths of 4250 m. The surface CH4 concentrations were above atmospheric equilibrium, both in the SCS and the WPS, with an average concentration of 4.5±3.6 and 3.0±1.2 nM, respectively. The sea–to–air fluxes were computed, showing that the SCS emits CH4 at a rate of 8.6 µmol m−2 d−1 and the WPS at a rate of 4.9 µmol m−2 d−1. In the SCS, the CH4 emissions were lower over the continental shelf (11.0 µmol m−2 d−1) than over the deep ocean (6.1 µmol m−2 d−1), owing to higher productivity and closer coupling with the sediments in the continental shelf. The SCS emitted 30.1±10.6 mol d−1 CH4 to the atmosphere and exported 1.88±10.6 mol d−1 CH4 to the WPS during the wet season. Both the concentrations of CH4 and chlorophyll a were higher in the 200 m surface layer of the WPS, however, not correlated unlike recent reports suggesting the occurrence of CH4 production in the surface ocean is related to phytoplankton activity. CH4 concentrations generally decrease with depth below the euphotic zone but remain constant below 1,000 m, both in the SCS and the WPS. South China Sea high CH4 models, from different simulations, indicate different responses in the different sectors (Atlantic, Indian and Pacific) of the Southern Ocean for these experiments.
Coastal vulnerability to climate change-induced sea-level rise may be increased by land motion and human factors

V. Ballu (1); J. Aucan (2); V. Duval (3); F. Magnan (3); B. Pelletier (4); M. Gravelle (5); C. Payri (1); M. Becker (8); F. Hossain (9); P. Simeoni (10); P. Valty (11); S. Calmant (8); Z. Khan (12); T. Kanas (13); L. Testut (14)

1) IRD, LEGOS, Toulouse, France; 2) IRD, Legos, Nouméa, New Caledonia; 3) UMR LERMA Université de La Rochelle, Nienss, La Rochelle, France; 4) M. Gravelle, Cnrs/Université de la rochelle, lienss, la rochelle, France; 5) Cnrs/University of la rochelle, lienss, la rochelle, France; 6) Ohio state U./school of earth sci., Div. of geodetic science, Colombus, United states of america; 7) University of Washington, Dept. of civil & environmental engineering, Seattle, United States of America.
Influence of climate changes on mangrove ability to fix and store CO2

C. Marchand (1); T. Meziame, (2); M. Allenbach (3); A. Leopold, (3); TT. Nhu Tranq (4); A. Alfaro (5)

(1) Institut de Recherche pour le développement (IRD), Paris, France; (2) MNHN, Paris, France; (3) University of New Caledonia, Noumea, New Caledonia; (4) University of Sciences, VNU, Ho Chi Minh City, Vietnam; (5) University of Technology of Auckland, Auckland, New Zealand

Mangroves are forested ecosystems developing in the intertidal zone of tropical and subtropical coastlines. They cover up to 140,000 km² worldwide, and extend from 30°n to 38°s (1). The vast majority of mangroves are found along the coasts of the Indo-Pacific area. They are amongst the most productive ecosystems in the world (2). Furthermore, they have been suggested to be enhancers of heterotrophic secondary production and offshore fisheries. In addition, it is well recognised that mangroves play a key role in shoreline protection, owing to their high abundance of food, shelter, and breeding and nursery habitats for a diverse community of terrestrial, aquatic and aerial organisms, including many endangered species (3). At a larger scale, the high net primary productivity of mangroves and low decomposition rates results in a net export of carbon from the coastal ecosystems to the atmosphere (4). In addition, mangroves are crucially important ecologically and economically, supporting the vast variety of ecosystem services (5). For example, mangroves stabilize the shoreline and serve as barriers against erosion. One of the most dramatic examples of the efficiency of this biological system as protection from catastrophic climatic events was demonstrated in 2004, when a large-scale tsunami devastate most coastal areas, but mangrove forested shores were significantly less affected (6). The annual economic value of mangroves, in comparison with similar ecosystems, has been estimated to be US$ 200,000–900,000 ha⁻¹ (7). Mangrove ecosystems have been decreasing dramatically worldwide, mainly due to habitat destruction. Once mangroves covered more than 228,000 km² worldwide (8). However, the growth and urbanization of coastal areas, expansion of industrial activities, and exploration and exploitation of natural resources have resulted in a current decrease in mangrove cover of 1% per year. This declining rate is equivalent or even higher than that of other threatened ecosystems, such as coral reefs or primary forests (9). Mangrove ecosystems also are also threatened by climate change. However, the responses of mangrove ecosystems to climate changes are not well understood (10). Relative sea-level rise may be the greatest threat to mangroves because most mangrove sediment surface elevations are not keeping pace with the rate of increase of sea-level (11). Also, the increases of temperature and atmospheric CO2 concentrations may also modify their functioning and distribution. Reduced mangrove area and health will increase the risk of safety and shoreline development from coastal hazards, such as erosion, cyclonic events, and tsunamis (12). Mangrove habitat loss also may result in coastal system loss of water quality, biodiversity, and fish and crustacean/bird production and nursery functions. Such ecological deterioration may have direct and indirect adverse effect on adjacent coastal habitats, and may eliminate a major resource for human communities that rely on mangroves for numerous products and services. Mangrove destruction also has the potential to release large quantities of stored carbon, which can have dramatic global implications (13). A synthesis of the current knowledge will be proposed, and our project of mangrove monitoring in the Indo–Pacific area will be presented.

Dengue fever is the most important mosquito–borne viral disease, with 390 million people being infected each year and 3 billion people living in areas at risk of dengue worldwide. The rapid global spatial spread over the past 40 years is likely to be due to recent socio–economic changes, such as global population growth and uncontrolled urbanisation, in combination with suitable climatic conditions. Dengue fever can establish itself in a given country, for it is transmitted by a number of mosquito species, mainly Aedes aegypti, whose life cycle is influenced by temperature and rainfall and humidity. In the following contribution, we focus on the South Pacific region, a vast, oceanic region where dengue epidemics are recurrent, aiming at disentangling socio–economic factors from climate factors.

We first analyse an original dengue database covering the 1972–2009 period across the South Pacific. In the Pacific region, dengue epidemics occurred every 3 to 6 years, with each epidemic wave caused by the regional circulation of 1 of the 4 dengue virus serotypes, with very limited A. A. Vulpie co–circulation. Assuming apparent spatio–temporal propagation patterns in the region, and countries such as French Polynesia and New Caledonia are the most regularly affected. There is a weak anti–correlation between the major El Niño Southern Oscillation (ENSO) events and the number of cases. The annual number of countries experiencing an epidemic, suggesting a link between climate and dengue epidemics. However, while the South Pacific has experienced a weak + 0.3°C trend in temperature over the last 3 decades, the overall regional long–term trend in the evolution of the number of affected countries for the past 40 years. However, local trends exist: New Caledonia is experiencing a positive trend whereas dengue epidemic frequency is decreasing in some smaller islands. We then analyse dengue epidemic profiles per country (endemic, regular epidemics, or sporadic epidemics). We identify variables linked to the different profiles. A statistical approach is based on variables characterizing the socio–economic situation (e.g. GDP) or climate (e.g. temperature) in each country. These statistical models are able to reproduce the major epidemic profiles. Assuming the socio–economic variables to remain constant over time, we project these models for the next 100 years using models of the IPCC–AR5 under RCP8.5.
Mass mortality events in atoll lagoons: present environmental control and increased future vulnerability with climate change

S. Andreoufet (1); C. Dutheil, (1); C. Menkes (2); M. Bador (3); M. Lengaigne (4)

(1) IRD, Noumea, New Caledonia; (2) IRD, LOCEAN, Noumea, New Caledonia; (3) CERFACS, Climate Modelling and Global Change team, Toulouse, France, France; (4) UPMC, Paris, France.

Several geomorphologically closed atolls of the Pacific Ocean have experienced in recent decades mass benthic and pelagic lagoon life mortalities, that are due to unusual calm weather conditions lasting for several weeks. These events, although poorly known and characterized, pose a complex environmental sustainability issue to the islands, and need to be taken into account for long-term resource management. A sample of eleven mortality events on eight atolls from the central South Pacific occurring between 1993 and 2012 were revisited to estimate the environmental thresholds required to trigger such events. We investigated thresholds and spatial patterns of sea surface temperature, significant wave height and wind stress satellite data. Then, using these thresholds, spatial maps of present-day potential risk are produced for the central South Pacific region. The highest risk zone lies north of the Tuamotu Archipelago in French Polynesia. To assess future risks in a climate change era, a regional climate model is used to downscale the projected future climate and to estimate the potential change in risk by the end of the 21st century. This process highlights a relative risk increase of up to 60% for the eastern Tuamotu atolls. However, caution is required given the limited number of case-studies available to train the analysis and identify thresholds. This study suggests that long-term monitoring of the biophysical conditions of the lagoons at risk is needed to precisely identify the physical thresholds and better understand the biological processes involved in these rare, but consequential, mass mortality events.

Mesopelagic heterotrophic N2 fixation related to organic matter composition in the Solomon and Bismarck Seas (Southwest Pacific)

M. Benavides (1); PH. Moisandier, (2); H. Bethelot (3); T. Dittmar, (4); O. Grosso (5); S. Bonnet (6)

(1) Mediterranean Institute of Oceanography, Marseille, France; (2) University of Massachusetts Dartmouth, Biology, Dartmouth, United States of America; (3) Aix Marseille University, Mediterranean institute of oceanography, Marseille, France; (4) Institute for Chemistry and Biology of the Marine Environment, Research group for marine geochemistry, Oldenburg, Germany; (5) CNRS, Mediterranean institute of oceanography, Marseille, France; (6) IRD, Mediterranean Institute of Oceanography, Noumea, France.

The oceans, play a key role in absorbing carbon dioxide (CO2) emitted by human activities. This absorbing power depends largely on the activity of microalgae, which take up CO2 using nutrients and sunlight. The availability of nutrients is thus essential for maintaining life in the oceans and balancing global cycles. In open ocean areas nitrogen is mainly provided through nitrogen fixation, a process performed by specific microorganisms called diazotrophs. Primary production in the oceans is strongly limited by the availability of fixed nitrogen. In open ocean nutrient–impoverished areas, which make up ~50% of the global ocean surface, nitrogen is mainly provided through the process of biological atmospheric nitrogen (N2) fixation. N2 fixation is carried out by so termed diazotrophs, marine microorganisms that may belong to the cyanobacteria, bacteria or archaea. For marine diazotrophs, autotrophic nitrogen fixation is the most abundant diazotrophs in the ocean. Autotrophic diazotrophs need light to fix carbon dioxide via photosynthesis, and therefore are constrained to the sunlit layer of the ocean, which generally less than 100m deep. Recent investigations have revealed that heterotrophic diazotrophs, which cannot photosynthesize, are present in greater abundance than autotrophic diazotrophs in the world’s oceans. Heterotrophic diazotrophs are constrained by the availability of light and therefore are able to live in the dark ocean, the largest and least studied habitat on Earth. This discovery significantly expands the biodiversity where N2 fixation potentially occurs, and theoretically increases the inputs of fixed nitrogen to the ocean, which remain unaccounted for. The diazotrophs inhabiting mesopelagic dark waters are heterotrophic and depend on organic matter for their nutrition. In this habitat, these microorganisms can live in association with oxygen minimum zones or local oxygen deficit microzones like organic particles. However, the relationship of heterotrophic diazotrophic activity and diversity with organic matter is unknown. We investigated N2 fixation along two transects in the Bismarck and Solomon Seas (Southwest Pacific, Transects 1 and 2 respectively). In transect 1, transparent exopolymer particles (TEP) where higher and oxygen concentrations lower than in Transect 2. The presence of N- and P-containing dissolved organic matter (DOM) compounds was also higher in Transect 1 than in Transect 2, as revealed by Fourier transform ion cyclotron mass spectrometry. N2 fixation rates (0.09–1 nmol L−1 d−1) were higher in Transect 1 than in Transect 2, and correlated positively with TEP and negatively with oxygen, reflecting the dependence of mesopelagic heterotrophic diazotrophic activity on organic matter. The scores of the multivariate ordination of DOM samples (principal coordinate analysis) were negatively correlated with bacterial abundances and positively correlated with N2 fixation rates. We interpret these results as an active bacterial exploitation of the DOM pool and its use to sustain diazotrophic activity. Phylogenetic analyses of the nifH gene detected S-1, O-5, O-10 and β-proteobacteria (Cluster I), Cluster II and Cluster IV. The relative importance of anaerobic Cluster III phylotypes in our clone library (26% of sequences), suggests that N2 fixation was partially supported by diazotrophs with a particle–attached lifestyle. Custom-designed quantitative PCR primer–probe sets were designed for three selected phylotypes. The abiotic process of biological nitrogen close to Cluster III ranged from undetectable to 1000 nifH gene copies L−1. Altogether, our results provide new insights into the mysterious ecology of heterotrophic diazotrophs and suggest that in situ fixation plays a critical role in nitrogen fixation activity. The input of fixed N2 by these organisms is significant and potentially contributes significantly to nutrient replenishment and primary production in the SW Pacific.
The role, changes in the SO have global ramifications. In fact, such changes are already underway. Under present-day climatic conditions, the SO remains particularly under-explored. The SO extends over a vast area of the Earth’s surface and it is located far away from the other continents and most of the research effort centers on weather patterns and satellite coverage rather than on in situ data acquisition with deployment of instrumented profilers and moorings. The SOCLIM (Southern Ocean and Climate) project intends to implement a cutting-edge approach that will quantitatively and qualitatively improve the understanding of the SO via pioneering in situ data acquisition with deployment of instrumented profilers and moorings.

Ten new-generation Bio-Argo floats were launched in water off South of Africa in the Antarctic Circumpolar Current from December 2014 to January 2015 and they are now entering the Indian sector of the Southern Ocean. They are collecting data in the Sub-Antarctic and Antarctic zones south east of Africa and around the Kerguelen Plateau. We will present the first data gathered during the austral summer and fall 2015. They will provide first insights in the dynamics of the termination of phytoplankton blooms in different environments and contribute to quantify the biological pump of CO2 in the SO. We will present the plan for the deployment of an instrumented mooring in the region of Kerguelen to be deployed in 2016.

P-1111-04 Carbon production and export are fuelled by dinitrogen fixation and dissolved organic nitrogen in the South-western Pacific Ocean: results from the VAHINE mesocosms experiment

S. Bonnet (1); H. Berthelot (2); T. Moutin (2); S. L’héguen (3); K. Leblanc (4); S. Helias (4); O. Grosso (4); N. Leblond (5); B. Charrière (6)

(1) IRD, Mediterranean Institute of Oceanography, Nourme, France; (2) Aix Marseille University, Mediterranean institute of oceanography, Marseille, France; (3) University of Bretagne Occidentale, Lorient, Brest, France; (4) CNRS, Mediterranean institute of oceanography, Marseille, France; (5) CNRS, Centre de recherche et de recherche sur les environnements méditerranéens, Perpignan, France

The oligotrophic ocean represents 80% of the global surface ocean. Its role on CO2 sequestration has long been considered to be low, but this view is currently changing. By new studies highlighting alternative pathways for carbon export to the deep ocean. In these systems, carbon production is limited due to nitrogen (N) scarcity but dinitrogen (N2) fixation and dissolved organic nitrogen (DON) could represent significant nitrogen (N) sources for the ecosystem. Here we deployed in New Caledonia large in situ mesocosms in order to investigate (1) the contribution of N2 fixation and DON use to primary production (PP) and particle export and (2) the fate of the freshly produced particulate organic N (PON) i.e. whether it is preferentially accumulated and recycled in the water column or exported out of the system. The mesocosms were fertilized (P) in order to prevent P-limitation and promote N2 fixation. The dinitrobacter community was dominated by diazotrophs associations (DDAs) during the first part of the experiment all along the experiment. The contribution of N2 fixation was not significantly different during P1 (9.0±3.3 %) and P2 (12.6±6.1 %). However, the e-ratio that quantifies the efficiency of a system to export particulate organic carbon (POCexport) compared to PP (e-ratio = POCexport/PP) was significantly higher (p<0.05) during P2 (39.7±24.9 %) than during P1 (23.9±20.2 %) indicating that the production sustained by UCYN-C was more efficient at promoting C export than the production sustained by DDAs. During P2, both PON concentrations and PON export increased in the mesocosms by a factor 1.5-2. Unlike in P1, this PON production was not totally exported by the new circulation. The use of DON, which concentrations decreased significantly from 5.3±0.5 µM to 4.4±0.5 µM, appeared to be the missing N source. The DON consumption of about 0.9 µM during P2 is even higher than the total amount of new N brought by N2 fixation (about 0.25 µM) during the same period. These results suggest that while DDAs mainly rely on N2 fixation for their N requirements, both N2 fixation and DON can be significant N-sources for carbon production and export following UCYN-C blooms in New Caledonia and by extension in the N-limited Ocean where similar events are likely to occur. This study confirms that in the South West Pacific, N2 fixation is a biogeochemically relevant process able to provide sufficient new N to drive new carbon production and export. These results are particularly important in the context of increasing temperatures that will probably increase the dinitrogen activity in the future ocean.

P-1111-05 The role of dinitrogen fixation on carbon export in the South Pacific: results from the OUTPACE project (Oligotrophy to Ultra-oligotrophy south Pacific Experiment)

S. Bonnet (1); T. Moutin (2)

(1) IRD, Mediterranean Institute of Oceanography, Nourme, France; (2) Aix Marseille University, Mediterranean institute of oceanography, Marseille, France

The additional CO2 in the atmosphere, mainly resulting from fossil fuel emissions linked with human activities (anthropogenic CO2), is the main cause of global warming. The ocean has acted as a major sink of anthropogenic CO2 preventing a greater accumulation in the atmosphere and therefore a greater increase in the earth temperature. Although the biological pump provides the main explanation for the vertical gradient of carbon in the ocean, it was thought to be in an equilibrium state with an associated near-zero net exchange of CO2 with the atmosphere. Climate alterations are now entering the Indian sector of the SO. We will also present the plan for the deployment of a cutting-edge approach that will qualitatively and quantitatively improve the observation of the Southern Ocean revealed using ARGO floats and data from instrumented elephant seals.

C. Chapman (1); J.B. Sallée (2)

(1) CNRS,LOCÉAN-IPSL, Paris, France; (2) Sorbonne Universités, LOCÉAN-IPSL, Paris, France

The meridional overturning circulation (MOC) of the Southern Ocean is a fundamental component of the climate system. The MOC exhibits first order control over the heat and CO2 budgets of the globe, forming the Earth’s
large CO2 sink and mediating the exchange of heat, salt, and nutrients between surface marine ecosystems and the deep ocean basins. Understanding the MOC is vital for understanding the climate system and predicting its future states.

To date, the vast majority of studies interpret the Southern Ocean MOC through a quasi-2-dimensional framework known as the Transformed Eulerian Mean (TEM). The TEM framework, developed for the study of the large scale atmospheric circulation, generally relies on or streamwise averages. However, the Southern Ocean circulation is not 2-dimensional. Phenomena such as meso-scale turbulence, forced topographic meanders and mixing by bottom topography, are highly localized due to the interaction between the Southern Ocean currents and large scale bathymetry. These local dynamics challenge the regional, but the global potential vorticity structure of the Southern Ocean. This means that these local dynamics might have a strong influence on the Southern Ocean. We will present the results of a systematic program to study the MOC as a 3-dimensional system. Employing hydrographic profiles obtained from ARGO floats, crustal and oceanic currents we develop maps of the 3-dimension potential vorticity, geostrophic velocity and the associated ﬂuxes due to stationary meanders. Using approximate force balances, we will use these maps to investigate the local overturning in the upper 2000m. Finally, we will discuss the implications for the large scale overturning.

P.1111-07

The O2C3 Project: Observing Pacific island societies facing climate change. Methodological, epistemological, ethical, and political implications

V. David (1); P. Lemere (1); C. Sabinot (2); G. David (3); M. Mangeas (4); E. Rodary (5); V. Naidu (6)

(1) IRD, Département sociétés umr gred, Nouméa, New Caledonia; (2) IRD, UMR 228 "espace pour le développement", Nouméa, New Caledonia; (3) Institut pour le Développement, UMRS Espace DEV, Montpellier, France; (4) Institut de recherche pour le développement, Mathematics, espace-de/Dev, Montpellier, France; (5) IRD, Département sociétés umr gred, Montpellier, France; (6) University of the South Pacific, Suva, Fiji

Pacific island societies bear the historical hallmark of vulnerability to, mobilites and resilience. They have displayed adaptive capacities on the long run as far as livelihood, social institutions and political organization are concerned. The current intensification of global and climate changes could jeopardize these policies as well as pushing them to elaborate innovative solutions to face these dramatic trends. Current research programs carried out by IRD social scientists with colleagues from other disciplines (health, ocean, marine governance and the value of land) give clues about the individual and collective agency developed by Pacific islanders to deal with the risks and uncertainties inherent in this unstable situation. Against these emerging and serious challenges, there is a growing consensus about the need to think more broadly and Oceania-wide by sharing information, establishing data bases, and participative research for engaging the human and societal dimensions of climate change. The joint Francophone Pacific and Anglophone Pacific project Ocean observatory of Climate Change and its Consequences for Pacific societies (O2C3) is an effort to implement the COPs, the South Pacific Integrated Observatory for the Environment, Terrestrial and Marine Biodiversity in the Social Sciences and Humanities, to enhance cooperation and collaborative initiatives. The observatory is developed in New Caledonia and Fiji (USP) but with the intention to promote immediate Oceania wide collaboration.

The focus of the O2C3 observatory would be on peoples’ knowledge, norms and practices in an encompassing framework, including various registers of knowledge: local, traditional, scientific, statistical, legal, professional... This self-evident idea raises serious challenges as far as methods, epistemology, data management and ethics are concerned. Collecting legal text and dealing with the issue does not raise specific difficulty, aside from localizing and accessing sources and making relevant information available to all. Identifying mobility forms linked to climate change (climate and environmental refugees, let alone mining refugees) is also feasible. When it comes to local knowledge, practices and representations of environmental and climate changes, things become trickier. There is a need for developing an in-depth reflection (1) on pertinent disciplinary and trans-disciplinary concepts that could be mobilized in social sciences for collecting, analyzing and interpreting these data and (2) on the methodological and ethical implications of this type of data production and maintenance.

The O2C3 project seeks to contribute to this effort by bringing together social scientists to cooperate on the human dimensions of climate change. The first step would be to develop a collective framework on the issue of producing, collecting, managing social data on climate change and how to make them available quickly to stakeholders and decision makers. The second step would be to establish an expanding network of social scientists and humanities scholars with institutional links in Melanesia and Polynesia Countries and Territories (PCTs) people’s awareness of climate change causes and consequences, stake holder standpoints, and governments’ policies and policy implementation on climate change. Third step, it will build and host a shared digital database of information relating to climate change that will be a useful resource for above-mentioned decision makers, academics and other stakeholders.

P.1111-08

Variability in subtropical-tropical cells drives oxygen levels in the tropical Pacific Ocean

O. Duteil (1); C. Boening (1); A. Oschlies (1)

GEOMAR, Kiel, Germany

Previous studies found a negative trend in oxygen concentrations in tropical regions during the last decades. Employing a biogeochemical circulation model, we highlight the importance of wind driven ocean transport associated with the Subtropical–Tropical Cells (STCs) in setting the oxygen levels in the tropical ocean. The observed and simulated slowdown of the STCs by 30 percent from the 1960s to the 1990s caused a decrease in oxygen transport to the tropics. Transport of phosphate was similarly reduced, causing production and respiration. The effects of physical transport and biological consumption partly compensate, damping oxygen interannual and decadal variability. Our results suggest that the observed residual oxygen trend in the tropical Pacific is mainly driven by changes in oxygen transport. Accordingly, the observed recent strengthening of the STCs leads us to expect a pause in the oxygen decrease or an increase of tropical Pacific oxygen values in the near future.

P.1111-09

Impact of the initialization with different ocean reanalysis on forecast bias in seasonal hindcasts

E. Exarchou (1); C. Prodhomme (1); V. Guemas, (1); F. Doblas-Reyes (1)

IC3, Barcelona, Spain

We analyze seasonal hindcasts performed with EC–Earth3 that are initialized from two different ocean reanalysis estimates (ECMWF–ORAS4 and MERCATOR–GLORYS2V1), which go to the model’s initial state. We analyze the impact of the initialization on the forecast bias in ocean reanalysis on the model bias and the model forecast skill. The seasonal hindcasts are four months long, consist of 10 ensemble members and they are initialized every May and November between 1993 and 2009. We find that the forecast initialized with ORAS4 is globally more skillful than the one initialized with GLORYS, particularly in the tropics. To study how the SST bias development relates with skill, we focus on the Tropical Atlantic and on particular specific regions: the Atlantic3 region (ATL3), and the Angola–Benguela Area (ABA), where most climate models exhibit strong systematic biases. In both sets of hindcasts, a strong cold surface temperature bias develops in one month in winter in ATL3. The biases in ATL3 in the hindcasts initialized with GLORYS2V1 are particularly strong in 1997, 2001 and 2003, and are caused by subsurface temperature errors in GLORYS. Despite the warm surface temperature
P-1111-10

Ant invasions in the light of climate change: forecasting a major threat for island biodiversity and economy

H. Jourdan (1); C. Gomez (2)
(1) IRD--Institut de Recherche pour le Développement, UMR 237 imbe, Nouméa, New Caledonia; (2) IRD--Institut de Recherche pour le Développement, Umr 237 imbe, Nouméa, New Caledonia

In the last four centuries, spread of exotic species have been steeply rising through human mediated transportation, and have been responsive for major changes to natural ecosystems as well as major consequences and damages to human activities with tremendous associated economic costs. This situation is especially exacerbated in island context, where biological invasions are considered as the main driver of change and threat for both biodiversity and human societies. In the same context, the whole biosphere is experiencing consequences of climate change. There is, now, a wide consensus that climate change will also contribute to exacerbate threats posed by invasive species to ecosystems and human societies. Scientists estimate that this will be especially true for ectotherm organisms, whose current distributions are limited by thermal barriers. But to date, these assumptions have not been widely tested or validated. Among ectotherm organisms, ants are recognised as major invasive organisms, according to their high contribution and dominance in ecosystems, high aggressiveness in context of invasion as well as economic losses related to their spread (decreased of agricultural production, damage to infrastructure, management expenses...). Then this insect group represents an ideal biological model to test current assumptions, especially in the context of fragile insular ecosystems which are considered as major biodiversity hotspots.

Here we present first results of a study, which aims at providing a better understanding of the patterns and processes behind ant invasions as well as the impacts they have on invaded communities and the projections that one can infer from these for the future as a consequence of global environmental change (under climate change driver).

To better understand the main determinants of the distribution of exotic ant species, we developed species distribution models (SDM) to predict suitable ranges for 20 major invasive ants across Pacific islands. We also explored the evolution of these patterns in the future. We modeled current distributions, based on bioclimatic parameters, soil characteristics and land cover. Future climatic data were sourced from the 5th IPCC assessment report, and it had been calibrated and statistically downscaled using the WorldClim data for ‘current’ conditions, in order to compare projections. Also, we used ordination analysis to define invasiveness potential and develop spatial projection of distribution models (sDM) to predict suitable ranges for 20 ant species assemblages, ecological determinants of the data have been use to recalibrate our prediction of the which is already affected by 16 ant species and at risk from invasiveness potential and develop spatial projection of distribution maps. Then, to better fit our predictions, we made a downscale to New Caledonia biodiversity hotspot, which is already affected by 16 ant species and at risk from the last 4 species. It provides us an unvaluable opportunity to validate in the field current occurrences, then field data have been use to recalibrate our prediction of the distribution. More answers are needed regarding future and specific limitations of SDM to determine of the distribution dynamics of introduced ants: How climate is impacting life history traits that will facilitate invasiveness? How ant species assemblages get structured under the influence of life history traits or biotic interactions?

NB: Our project is involved in a current European Eranet Biodiversa funded project 2013-2016 “FFii” Forecasting Future Invasions and their Impacts.”

P-1111-11

Climate change impacts on marine fisheries: assessing the catchment in Peninsular Malaysia

AHM. Kamal (1); J. Ismail (2); H. Idris (3)
(1) Universiti Putra Malaysia Bintulu Sarawak Campus, Animal Science and Fishery, Bintulu, Sarawak, Malaysia; (2) Universiti Putra Malaysia Bintulu Sarawak Campus, Animal science and fishery, Bintulu, Sarawak, Malaysia; (3) Universiti Putra Malaysia Bintulu Sarawak Campus, Animal science and fishery, Bintulu, Malaysia

Global climate change variations over the past 30 years have produced numerous impacts in the abundance and production performance of marine fish and fisheries worldwide. The consequences in terms of flooding of low-lying estuarine habitats due to over rainfall, fluctuation of temperature, dilution of water parameters, devastation of feeding and breeding habitats, salinity fluctuations and acidification of waters, high siltation in coastal area, changes in the sea water table and breeding triggers have raised serious concerns for the well-being of marine fisheries and their production. This study shows that the overall total catchment of marine fisheries was decreased 38% in 2009 compared to 1998 while considers the fishing gears and vessels number used in Peninsular Malaysia. Registered vessels number was increased up to 92% in 2009. In the same context, the whole biomass is experiencing consequences of climate change. There is, now, a wide consensus that climate change will also contribute to exacerbate threats posed by invasive species to ecosystems and human societies. Scientists estimate that this will be especially true for ectotherm organisms, whose current distributions are limited by thermal barriers. But to date, these assumptions have not been widely tested or validated. Among ectotherm organisms, ants are recognised as major invasive organisms, according to their high contribution and dominance in ecosystems, high aggressiveness in context of invasion as well as economic losses related to their spread (decreased of agricultural production, damage to infrastructure, management expenses...). Then this insect group represents an ideal biological model to test current assumptions, especially in the context of fragile insular ecosystems which are considered as major biodiversity hotspots.

Here we present first results of a study, which aims at providing a better understanding of the patterns and processes behind ant invasions as well as the impacts they have on invaded communities and the projections that one can infer from these for the future as a consequence of global environmental change (under climate change driver).

To better understand the main determinants of the distribution of exotic ant species, we developed species distribution models (SDM) to predict suitable ranges for 20 major invasive ants across Pacific islands. We also explored the evolution of these patterns in the future. We modeled current distributions, based on bioclimatic parameters, soil characteristics and land cover. Future climatic data were sourced from the 5th IPCC assessment report, and it had been calibrated and statistically downscaled using the WorldClim data for ‘current’ conditions, in order to compare projections. Also, we used ordination analysis to define invasiveness potential and develop spatial projection of distribution models (sDM) to predict suitable ranges for 20 ant species assemblages, ecological determinants of the data have been use to recalibrate our prediction of the which is already affected by 16 ant species and at risk from invasiveness potential and develop spatial projection of distribution maps. Then, to better fit our predictions, we made a downscale to New Caledonia biodiversity hotspot, which is already affected by 16 ant species and at risk from the last 4 species. It provides us an unvaluable opportunity to validate in the field current occurrences, then field data have been use to recalibrate our prediction of the distribution. More answers are needed regarding future and specific limitations of SDM to determine of the distribution dynamics of introduced ants: How climate is impacting life history traits that will facilitate invasiveness? How ant species assemblages get structured under the influence of life history traits or biotic interactions?

NB: Our project is involved in a current European Eranet Biodiversa funded project 2013-2016 “FFii” Forecasting Future Invasions and their Impacts.”

P-1111-12

Inter-annual Variability of the Upper Ocean Temperature in the Tropical Western Indian Ocean

M. Manyilizu (1); D. Francois (2); P. Penven (3); C. Reason, (4)
(1) University of Dodoma, College of Informatics and Virtual Education, Dodoma, Tanzania, United Republic of; (2) Commonwealth Scientific and Industrial Research Organisation (CSIRO), Marine and atmospheric research, Wembley, Australia; (3) Institut de Recherche pour le Developpement (IRD), Centre de Bretagne, Bretagne, France; (4) University of Cape Town, Department of oceanography, Cape Town, South Africa

Interannual variability of the upper ocean temperature in the tropical western Indian Ocean has been studied using a regional ocean model. The strongest SST variability occurs in the offshore region lying over high subsurface temperature variations located between 30 and 130 m. Such a region corresponds with strong variations in the thermocline depth. The lowest SST variations occur in the Tanzanian shelf waters and lie over the subsurface waters with the smallest temperature variations in the upper 200 m. Such smallest temperature variations match with weak variations in the thermocline depth. However, the region with the highest variability of the subsurface temperature is more explained by interannual variability related to strong thermocline variations. The thermocline variations can be associated with local Ekman pumping and/or remote influence from the large-scale climate modes. Anomalous warming and downwelling (upwelling) Rossby waves generated during ENSO and IOD events lead to anomalies in the thermocline depth and hence in subsurface temperature. The strong variations in the offshore region is related to strong interannual variability in the thermocline associated with ENSO and the IOD.
THOT (Tahitian Ocean Time series): a new kind of long-lasting deep-sea oceanographic station in the central South Pacific

E. Martinez (1) ; H. Claustre (2) ; M. Rodier, (1) ; A. Poteau (2) ; A. Mignot (3) ; M. Taquet (1) ; C. Ponsonnet (4) ; K. Maamatauialahutapu (5) ; C. Maes (6)

(1) IRD–Ifremer–UPF–ILM, Ecosystèmes insulaires océanïens, Tahiti, French Polynesia; (2) CNRS–Université Pierre et Marie Curie, Laboratoire océanographique villefranche, Villefranche sur mer, France; (3) Massachusetts Institute of Technology, Cambridge, Massachusetts, United States of America; (4) Direction des Ressources Marines et Minières, Tahiti, French Polynesia; (5) University of French Polynésie, Tahiti, French Polynesia; (6) IRD–CNRS–Ifremer–UBO, Laboratoire de physique des océans, Plouzane, France

The objective of the Tahitian Ocean Time-series (THOT) project is to set up a deep-sea oceanographic station to observe and improve the understanding of climate changes in the French Polynesia waters as representative of those in the subtropical gyres of the global ocean. To observe and characterize climate changes in this region, the deployment of long-lasting oceanographic survey stations is necessary to follow the evolution of oceanographic key parameters (e.g., temperature, salinity, oxygen, phytoplankton biomass). However, presently there is no deep-sea monitoring observatory in the central South Pacific.

Implementation of a mooring station, such as those already existing, is complex in French Polynesia due to its geographical, scientific, logistical and technological remote context. Thus the originality of THOT is to set up a long-lasting station to observe climate changes based on 1) a regular deployment of physical–biogeochemical profiling floats in the area of interest over the next two/three years; 2) then to deploy the next generation of biogeochemical profiling floats capable of horizontal displacement to replace in their initial position.

Diazotrophic impacts on the biogeochemistry of the South Western Tropical Pacific and the implications of rising temperature and CO2

The Physical Basis of Arctic Change

C. Lee (1)

(1) University of Washington, Seattle, United States of America

Research suggests that the Arctic responds to climate change earlier and with greater intensity, than other components of the earth system, making it a useful barometer for the health of the global environment. Observed changes in the Arctic marine and cryosphere, including increased seasonality, rapid sea ice loss and accelerated melting of the Greenland ice sheet, are consistent with these ideas of 'Arctic amplification'. Such changes can produce substantial environmental and societal stress, with regional implications and potentially profound global impacts. The resulting challenges include accelerated coastal erosion, changing weather patterns and rising sea level. Arctic environmental change can also produce new opportunities, such as expanded resource extraction and shortened shipping routes. Accurate predictions of Arctic environmental change and its global impacts are needed to inform the response to these challenges and support planning of future activity.
Assessment of Arctic Feedbacks

K. Reistad (1)
(1) University of Miami, Miami, FL, United States of America

Radiative feedbacks in the Arctic play a key role in determining the energy and moisture budgets both at the surface and top of atmosphere which, in turn, influences the atmospheric and oceanic circulation. The Arctic has experienced dramatic declines in summer sea ice over the past decade which has triggered a series of interconnected responses in the surface energy budget and the Arctic climate. The Arctic has become warmer, wetter, and cloudier. All of these changes further modulate the radiative fluxes at the surface. Observations indicate that the most pronounced warming occurs during boreal winter, with an increase in Arctic mean temperature of roughly 1K. This warming is associated with a pronounced sea ice loss in boreal summer which increases the evaporation rates (i.e. moisture flux). This results in enhanced water vapor and cloud cover enhances the downward long wave flux at the surface, contributing to earlier melt onset and the delayed autumn freeze up. This study will summarize the importance of these relationships using multiple observational data sets and compare the observed feedback strengths to those simulated in coupled ocean- atmosphere models.

Biological impacts of recent climate change in the Arctic

D. Hik (1)
(1) University of Alberta, Department of Biological Sciences, Edmonton, Alberta, Canada

The ecology of the Arctic is changing in response to shifts in the climate system. Although Arctic species are well adapted to seasonal and diurnal variability in physical conditions, many of the observed climate–driven changes are leading to fundamental shifts in the structure and diversity of biological processes. What happens in both the marine and terrestrial environments has both local and global implications. For example, the tundra is a huge biome extending across 30 degrees latitude. Vegetation changes show a complex pattern at larger scales, but overall there has been a rapid increase in woody vegetation (shrubs, trees), changes in phenology and albedo as a consequence of earlier snowmelt, and changes in foodweb structure and trophic interactions. Freshwater ecosystems are facing similarly large changes, and the ability of rivers, lakes and wetlands to maintain adequate streamflows, water levels and water quality for ecosystem sustainability is poorly understood. In the marine environment, there is already compelling evidence of a shift towards an increasingly pelagic system in the absence of summer sea ice. In both terrestrial and marine ecosystems, extreme events (e.g. winter rain, fire, storm surges) can overturn long-term trends, but there are still insufficient observations to adequately predict the future.

I will provide a brief overview of current understanding of how Arctic ecosystems are responding to climate change and the most important research needs identified during the 3rd International Conference on Arctic Research Planning (ICARP III).
ABSTRACT BOOK

Climate scenario simulations with global coupled climate models, contributing to the coupled model intercomparison project phase 5 (CMIP5), are used to exploit possible scenarios for the sea ice distribution under climate change during the coming decades. Their results are also discussed in the IPCC assessment report no. 5 (AR5). More than 30 models take part in the CMIP5 experiments and together they estimate a very large uncertainty range for Arctic sea ice. CMIP5 models simulate the global climate change and their individual strengths differ regionally. Several studies show that if a limited number of CMIP5 models are chosen with respect to their regional strengths, the range of uncertainty decreases considerably for selected variables.

Within the projects ACCESS (Arctic Climate Change, Economics and Society) and ICE-ARC (Ice, Climate, Economics and Society Research Arctic Research on Change) we compare satellite sea ice concentration observations with simulated sea ice concentration of 34 CMIP5 models. The skill of the models varies within the region in the Arctic, the time period of the satellite observation used and the satellite data processing. Thus, we analyse two different satellite derived products over individual regions, which have been discussed as potential sites for resource extractions, as well as the whole Arctic for two different time periods. From this, we select the best four CMIP5 models with regard to the misfit between model and observations. Although the models agree on the general future reduction on sea ice area, they differ in the magnitude of the sea ice decrease and thus the timing of when the Arctic becomes ‘ice-free’.

The sea ice coverage correlates well with the near surface air temperature in summer and with the position of warm Atlantic water during winter. These correlations exist in the chosen models but with strong differences. For example, the position of the warm Atlantic water entering the Arctic via the Fram Strait and the Barents Sea Opening varies considerably in the four chosen models. Therefore, one reason for the differences in future sea ice estimates from different models is the simulated change of the atmospheric and oceanic northward heat transport into the Arctic.

Different sea ice projections between climate models can be understood not only being due to differences of the sea ice model component, but the model realisation of oceanic and atmospheric northward heat transport.

1112 - POSTER PRESENTATIONS

P-1112-01

Reconstruction of the Greenland ice sheet surface mass balance over 1900-2014 with the help of the regional climate MAR model

X. Fettweis (1); H. Gallée (2)

(1) University of Liège, Department of geography, Liège, Belgium; (2) Laboratoire de Glaciologie et Géophysique de l’Environnement, Grenoble, France

With the aim of studying the recent Greenland ice sheet Surface Mass Balance (SMB) rates with respect to the last century, we have forced the regional climate MAR model with ERA-Interim (1979-2014), ERA-40 (1958-2001), NCEP1 (1948-2014), NCEP2 (1979-2014), 20CR (1880-2012) and ERA-20C (1900-2010) reanalysis. While all of these forcing products are reanalyses, MAR simulates significant differences in SMB over the common period. A temperature correction of +1°C (resp. -1°C) had notably to be applied to the MAR boundary conditions given that ERA-20C (resp. 20CR) is ~1° colder (resp. warmer) over Greenland than ERA-Interim data over 1980-2010.

Discrepancies in simulated SMB is particularly high in regions where SMB measurements are missing suggesting that uncertainties in the current SMB reconstruction are highlighted in observations and model results performed before performing future projections. Comparisons with SMB measurements (along K-Transsect), ice cores and satellite derived melt extent allows to select the best reanalysis forced data set.

All of these simulations show that i) the period 1961-1990 usually chosen as reference for SMB and ice dynamics (stable ice sheet) over Greenland is a period when the SMB was abnormally high in respect to the last 120 years; ii) SMB has been significantly decreasing after this reference period. Both ERA-20C and 20CR forced simulations suggest a precipitation increase over the last century but only the ERA-20C forced simulation suggests that SMB during the 1920-1930 warm period over Greenland is comparable with the SMB of the 2000’s.

1113 - Climate Extremes: Patterns, Mechanisms and Impacts

ORAL PRESENTATIONS

O-1113-01

The timing of anthropogenic emergence in climate extremes

A. King (1); M. Donat, (2); E. Fischer, (3); E. Hawkins (4); L. Alexander (2); D. Karoly (5); A. Dittus, (1); S. Lewis, (6); S. Perkins, (7)

(1) University of Melbourne, School of Earth Sciences, Melbourne, Victoria, Australia; (2) University of New South Wales, Climate change research centre, Sydney, Australia; (3) ETH Zurich, Switzerland; (4) University of Reading, Dept. of meteorology, Reading, United Kingdom; (5) University of Melbourne, School of Earth Sciences, University of Melbourne, VIC, Australia; (6) Australian National University, School of earth sciences, Canberra, Australia; (7) University of New South Wales, Climate change research centre, NSW, Sydney, Australia

Many extreme events can be attributed to anthropogenic climate change whilst others can not. This has motivated us to study the time of an anthropogenic emergence (TAE) of six indices representing temperature and precipitation extremes. We used multiple historical runs and RCP8.5 projections from six CMIP5 models. We define a quasi-natural variability for each of these indices at gridbox level and for sub-continental regions and the globe as a whole. We determine when an anthropogenic emergence occurs by comparing index distributions across moving windows with the quasi-natural variability. We also investigated how TAE compared for mean temperature and precipitation with extremes. We found earlier emergence of extreme temperatures in equatorial regions compared to other parts of the world and some seasonal variability in TAE. Spatial aggregation reduces variability in mean and extreme temperature and precipitation leading to earlier TAE values. Using limited observational datasets, the same TAE methodology was applied and signs of emergence found. Finally, using the CMIP5 models, we show the regions of the world where anthropogenic signals can already be detected in our temperature and precipitation indices to aid in the study of attribution of extreme events to climate change.

O-1113-02

Extreme heat waves with the Heat Wave Magnitude Index and their occurrence in the future

A. Dosio (1); J. Sillmann (1); S. Russo, (1)

(1) European Commission Joint research Centre, Institute for Environment and Sustainability, Ispra, Italy

Heat waves are defined as prolonged periods of extremely hot weather and their intensity, duration, and frequencies are expected to increase in the future under climate change.

Recently, a new Heat Wave Magnitude Index (HWMI) was developed that, by taking into account both heat wave duration and intensity, enables the quantification of the magnitude of heat waves across different time periods and
Here we first apply the HWMI to grade the observed heat waves occurred in Europe since 1950: in fact, although the worst event in the last decades occurred in Russia in 2010 (the shortest recorded globally in recent decades exceeding in amplitude and spatial extent the previous hottest European summer in 2003), many other heat waves, documented in literature and in newspapers, occurred in different European regions in the past decades.

Subsequently, we apply the HWMI to the predictions from several regional climate models (RCM) from the Coordinated Regional Climate Downscaling Experiment (CORDEX). RCMs have been used to downscale CMIP5 Global Circulation Models under different Representative Concentration Pathway (RCP), namely RCP4.5 and RCP8.5. We focus on two regions, Africa and Europe, for which a large ensemble of models’ results is available.

Results show that, by the end of this century, under the most severe emission scenario, events with magnitude even greater than the one in Russia in the summer of 2010 will become more frequent and are projected to occur as often every 10 years for regions such as southern Europe and central Africa.

The Role of Teleconnection Patterns in Wave Climate and Storms Distribution: The SW Spanish and Wales Coasts Examples

R. Nelson Guillermo (1); A. Giorgio (2); P. Michael (3); T. Thomas, (3)
(1) Universidad del Atlantico, Basic Sciences, Barranquilla, Colombia; (2) Cadiz University, Faculty of marine sciences, Cadiz, Spain; (3) Swansea University, Swansea City David (Swansea), Swansea, United Kingdom

Tele-connection patterns such as the North Atlantic Oscillation (NAO) and Arctic Oscillation (AO) are influenced by climate change, as models predict a weakening of the overturning circulation that may affect both regional and global climate, sea level and extreme waves. Observations and distribution of storms are important variables in the incidence of coastal erosion, deterioration and/or complete destruction of ecosystems. This work presents the characteristic and wave climate and energy, coastal storms and their recurrence intervals, related to several regional cycles in Cadiz (SW Spanish Atlantic coast), Tenby and Swansea (S Wales, UK). At the former site, wave records include 21 years of data covering the period between 1987 and 2012. Storm characterization was carried out using the Storm Power Index and five classes were obtained, from class I (weak events) to V (extreme events). Storm occurrence probability was 96% for class I (i.e. almost one event per year) to 3% for class V. The return period for class V was 25 years and ranged from 6 to 8 years for classes III and IV storms, e.g. significant and severe events. Classes II and III storms for recurrence frequency ranging from 1 to 3 years. Approximately 40% of the change in monthly wave data and storminess indices was related to several teleconnection patterns, being the Arctic Oscillation (AO), with 21.45%, and the North Atlantic Oscillation (NAO), with 19.65%, the most important drivers of change.

Timescales of Change: Unraveling East Africa’s Climate Paradox

B. Lyon (1); A. Giannini (1); N. Vignaud (1)
(1) IRI, Columbia University, Palisades, NY, United States of America

East Africa is currently facing something of a climate paradox. Over roughly the past 15 years, the region has been experiencing an increased frequency of drought, particularly along the eastern coastline in March-May. In a seeming contradiction, there is a general consensus among climate change projections that the region of East Africa will become wetter as a result of anthropogenic climate change by the end of the current century. One possible explanation of this discrepancy is that the climate models are not properly responding to increasing greenhouse gases and their influence on East African climate. The future climate of East Africa may in fact become drier, not wetter. Another possibility is that the recent rainfall decline is associated with processes in the climate system operating on shorter time scales than long-term climate change. In this case, the recent rainfall decline may be masking longer-term climate change. A third possibility is that there is an interaction of processes operating on these different time scales.

This paper will review recent and ongoing research that is helping to explain the recent variations in East African climate. A combination of observational and climate model experiments indicate that the recent rainfall decline in East Africa has been associated with decadal–scale variations of the climate system, specifically in the Pacific Ocean. Evidence is provided here that the recent rainfall decline in East Africa was manifest as an abrupt shift towards drier conditions that occurred in 1998–99 when the Pacific Decadal Oscillation (PDO) shifted from its warm to cold phase. This shift in PDO was associated with a significant change in the flow of eastern equatorial Pacific while the western Pacific has remained anomalously warm. Observational evidence indicates that the recent rainfall decline in East Africa was part of a near–global scale shift in seasonal rainfall patterns, with similar shifts observed previously over the past century. Results from climate model experiments, using only observed sea surface temperatures in the tropical Pacific as forcing, indicate the models are able to reproduce the recent drying in East Africa and the associated shift in global precipitation patterns. However, observations also indicate that the western Pacific warm pool region has continued to warm over the past several decades, an increase which almost certainly contains an anthropogenic component. Current work is investigating whether this combination of natural and anthropogenic changes can be identified in the modeled and anthropogenic change, particularly in sea surface temperatures in the Pacific warm pool region, led to an exacerbation of recent East African droughts (we note that the devastating drought in 2011–12, the driest on record in the last 50 years). Understanding the physical processes associated with climate model projected increases in East African rainfall and how realistic they are in light of what is known about the behavior of the current climate system remains a critical next step in fully unraveling the East African climate paradox.

Physical insights on future European summer heat waves and record-breaking temperatures

M. Bador (1); L. Terray (1); J. Boé (1)
(1) CERFACS/CNRS, Sciences de l’univers au cerfacs, ural875, Toulouse, France

Recent summer heat waves had strong socio–economic impacts in different parts of Europe. This highlights the need for improved understanding of key processes and feedbacks. We focus on the detection of an anthropogenic signal on record–breaking summer temperature using historical and 21st century simulations from a set of CMIP5 climate models all driven by the CMIP5–CM5 model. Based on warm spell duration indices, we select a few intense events that observed record evolutions follow the stationary climate theoretical record rate until the 1980s. They then diverge from the expected value, with an increase of the number of warm records and a decrease of the cold ones. These changes are shown to accentuate over the 21st century. The influence of internal variability based on control simulations is used to estimate an anthropogenic signal emergence time around 2030.

We then focus on a set of case studies of future heat waves. We analyze a high spatial resolution simulation (from 1950 to 2100) of the ALADIN regional atmospheric model driven by the CNRM–CM5 model. Based on warm spell duration indices, we select a few intense events that occur in the second part of the 21st century. Heat waves are generally associated with quasi–cyclonic circulation anomalies that produce clear skies and warm air advection. They are often associated to anomalously dry land surface conditions. For each case study, we perform ALADIN sensitivity experiments by perturbing either the prescribed large–scale circulation and/or the initial soil moisture content. We then infer the dominant mechanisms and the feedbacks operating to amplify or mitigate the heat waves. We also perform a worst–case scenario where we try to generate an extreme heat wave in order to assess the associated temperature rise and its possible saturation due to negative feedback.
Global future changes of precipitation extremes

A. Toreti (1); P. Naveau, (2); M. Zampieri, (3); A. Schindler, (4); E. Scoccimarro, (5); E. Xoplaki (6); H. Dijkstra, (7); S. Guaidi, (3); J. Luterbacher (6)

(1) European Commission, Joint Research Centre, Ispra, Italy; (2) Laboratoire des Sciences du Climat et de l’Environnement, IPSL- CNRS, GIF-sur-Yvette, France; (3) Centro Euro-Mediterraneo sui Cambiamenti Climatici, Lecce, Italy; (4) Office of Meteorology and Climatology, MeteoSwiss, Zurich, Switzerland; (5) Centro Euro-Mediterraneo sui Cambiamenti Climatici, Lecce, Italy; (6) Justus-Liebig-University Giessen, Geography: Climatology, Climate Dynamics and Climate Change, Giessen, Germany; (7) Utrecht University, Department of physics and astronomy, Utrecht, Netherlands

Precipitation extremes have a strong impact on ecosystems and societies especially in exposed and vulnerable areas. In a climate change context, where exposure and vulnerability are also expected to change, it is essential to achieve a better understanding and an improved characterisation of these events. By analysing the latest global climate model simulations from the Coupled Model Intercomparison Project Phase 5 and by using an innovative statistical approach, seasonal changes in daily precipitation extremes under the high emission (RCP8.5) and the mid-range mitigation emission (RCP4.5) scenarios are investigated. Two future time periods (2020–2059, 2060–2099) are selected with the historical time period 1966–2005 and the results presented in terms of very high risk events. Furthermore, global models are evaluated w.r.t. precipitation extremes by using the available (high-resolution) gridded observations during the selected time period of the historical run. At the European scale, complex changes in the tail behaviour are also assessed. Results show that in the historical period a reliable characterisation of precipitation cannot be achieved for large areas of the world, where an estimation of the return levels cannot be obtained. This is the case, for instance, during boreal winter for a belt elongated over the subtropics and the Northern Hemisphere. At the regional level, the oceanic areas west of the three continents of the Southern Hemisphere. In the Euro–Mediterranean area, northern Eurasia, and North America, the simulations show lower intermodel variability and higher correlation with the observations in boreal winter. Conversely, for Australia, southern Asia, and the Middle East, all seasons are characterised by larger intermodel variability and lower correlation with observations. Concerning the future projections, the main findings point to an intensification (more pronounced at the end of the century under the high-emission scenario RCP8.5) of precipitation extremes almost everywhere and for all seasons. However, a lack of reliability and consistency affects the subtropics/tropics. The zonal means of the identified changes clearly show more pronounced increases over the high latitudes of both hemispheres in all seasons, with the exception of the Northern Hemisphere in the mid–century boreal summer, associated with larger intermodel variability. Over the Southern Hemisphere, a sharp decrease in the estimated positive changes from the high to the middle latitudes is evident in all seasons followed by (with the exception of the austral winter) a strong increase towards the low latitudes. Stronger hemispheric differences are also estimated over the high latitudes for RCP8.5 at the second half of the century that are most prominent in summer and autumn. At the regional level, moist summer conditions are projected in the western part of return levels over land, although large variability affects the estimated seasonal changes over specific areas (e.g., eastern Asia in summer).

Weakened Flow, Persistent Circulation and Prolonged Heat Waves in Boreal Summer

D. Coumou (1); J. Lehmann, (1); K. Kornhuber, (1); V. Petrooukhov, (1)

(1) Potsdam Institute for Climate Impact Research, Potsdam, Germany

Changes in atmospheric circulation can strongly alter the frequency and/or magnitude of high-impact extreme weather events. The Northern Hemisphere mid–latitudes have seen significant changes in the large-scale summer circulation over the last decades and the boreal summer might have contributed to more prolonged heat waves (1–3). The zonal mean zonal wind (or “jet”) has weakened by about 5% over 1979–2014, likely driven by the much more rapid warming in the Arctic as compared to the rest of the Hemisphere. In conjunction with the summer jet, the kinetic energy associated with transient synoptic–scale weather systems (the Eddy Kinetic Energy, or EKE) has seen a significant weakening as well. The observed decline in EKE is most pronounced in relative terms than that of the jet (by about 10% over 1979–2014), which is consistent with theoretical arguments and climate model simulations. Transient eddies are both forced by the jet via vertical shear but can also accelerate it via the eddy–driven jet (4, 5). The observed summertime weakening of both jet and EKE is also a robust signal in future projections of CMIP5 climate models (5, 6). At the same time, for some wave numbers, we have seen an increased occurrence–frequency of high-amplitude quasi–stationary waves during recent boreal summers. We argue that this increase in frequency is associated with a recent cluster of resonance events which can create such high-amplitude waves.

The reduction in amplitude of fast–moving transient waves (as captured by EKE) and the more-frequent occurrence of high-amplitude quasi–stationary waves both favor more persistent weather conditions. It has been demonstrated that high-amplitude quasi–stationary waves in the atmosphere are statistically associated with extreme weather at the surface (7, 8). Especially regions at the western boundary of the continents show the strongest association between extreme surface events and high-amplitude upper–level waves. In contrast, strong transient wave activity, i.e. large EKE, is linked to moderate surface temperatures and vice versa (3). Over most continental regions affected by storm tracks, there is a significant negative correlation between monthly EKE and surface temperature. Thus, the hottest summers are associated with extremely low EKE, while mild summers are associated with more pronounced EKE. Again the western boundaries of the continents are especially sensitive since these regions are most directly influenced by the storm tracks.

In conclusion, boreal summer circulation has seen pronounced changes over the last decades, trends which seem to have amplified since the onset of rapid Arctic Amplification around 2000. Especially the reduction in EKE might also in zone–scale weather, favor conditions favorable for the buildup of heat and drought over the continents. Moreover, a cluster of resonance events is observed since 2000, which has increased the occurrence–frequency of high-amplitude quasi–stationary waves with wavenumbers close to 7. Thus, this generally implies a weakening of transient synoptic eddy activity and more-frequent states of quasi–stationary flow. These observed changes in large–scale circulation have created conditions favorable for the buildup of heat and drought over the continents. Additionally, the occurrence of heat waves has increased since 2000 and now reaches values comparable with the summer heat wave event in early 2003.

Climate Model Simulation of Present and Future Extreme Events in Latin America and the Caribbean: What Spatial Resolution is Required?

R. Oglesby (1); C. Rowe, (2); R. Mawalagedara, (3)

(1) University of Nebraska, Lincoln, Earth and atmospheric Sciences, Lincoln, Nebraska; (2) The Ohio State University, Climate and Space Department, Columbus, Ohio; (3) The British Antarctic Survey, Cambridge, United Kingdom

Climate model resolution is important for simulating the spatial distribution of extreme events in the region of interest and assessing the impact of future climate change on these events. In this study, we evaluate the impact of climate model resolution on the simulation of extreme events in Latin America and the Caribbean (LAC) using a high-resolution climate model (100 km) and a low-resolution model (500 km). The results show that the high-resolution model is able to capture more fine-scale features of extreme events, such as the location and intensity of extreme precipitation events, than the low-resolution model. This is particularly true in the tropical regions of LAC, where the high-resolution model is able to capture the spatial variability of extreme precipitation events. In contrast, the low-resolution model tends to smooth out the spatial variability of extreme precipitation events, leading to a more uniform distribution of extreme events across the region. This highlights the importance of climate model resolution in accurately simulating the spatial distribution of extreme events in LAC, which is critical for assessing the impact of future climate change on these events. The results also suggest that a higher spatial resolution is required for accurately simulating extreme events in LAC.
of TC rainfall, as compared with TRMM, possibly due to an underestimated TIE feedback. Moreover, our climate scenario suggests that the increase of spatially aggregated TC mean rainfall follows the CC relationship, while super CC rates are only reached in the very inner core of the TCs.

**O-1113-10**

**Temperature and precipitation extreme compound events in Southeastern South America and the associated atmospheric circulation**

M. Rusticucci (1); B. Tencer (1); ML. Bettolli, (2)

(1) School of Earth and Ocean Sciences, University of Victoria, Victoria, Canada; (2) University of Buenos Aires, Atmospheric and ocean sciences, Buenos Aires, Argentina

Compound events consist of the simultaneous or successive occurrence of two or more extreme events, the combination of extreme events with conditions that amplify the impact of the events, or the combination of events that are not individually extreme but can lead to extreme impacts when occurring together (IPCC, 2012). In this paper we analyse the joint occurrence of extreme temperature and heavy precipitation events (simultaneous or triggered by one day) in southern South America during 1961–2000.

The study is based on a comprehensive dataset of daily precipitation and daily minimum and maximum temperature observed at meteorological stations of the region and compiled during the CLARIS LPB project. Four different extreme temperature events were defined: warm nights (days) correspond to days with minimum (maximum) temperature exceeding the 90th percentile of the daily distribution; cold nights (days) are days with minimum (maximum) temperature below the 10th percentile. Heavy precipitation events are events with daily rainfall above the 75th percentile of the empirical distribution of rainy days. A compound event is defined when one of the above two events occurs simultaneously with, preceded or followed by a heavy precipitation event.

The existence of a significant statistical relation between these extremes could help to better characterize the uncertainties associated with projections of extreme precipitation events for a future warmer climate. Results show that the probability of occurrence of an intense precipitation increases during or, after a warm night, but decreases during a cold night, compared to the expected likelihood of occurrence of this type of events in the absence of a relation between temperature and precipitation dry extremes. Warm days are usually associated to the occurrence of heavy precipitation events on the same day or the day before, but they rarely occur afterwards. On the contrary, cold days happen more often after an intense rain.

In order to characterize the atmospheric circulation during the occurrence of a compound event, we use a synoptic classification developed by Barrucand et al (2014) and based on daily mean fields of geopotential height at 500hPa from the NCEP2 reanalysis. The associated circulation during a compound event of warm nights and warm days and heavy precipitation shows a trough over the Pacific Ocean and a cold front over the continent that lead to warm and wet air advected to the east of the region of study. Cold days and heavy precipitation events in the southwestern part of the domain of study are usually characterised by a positive anomaly of geopotential height at the southern part of the continent associated with an eastern anomaly over the region.

**P-1113-01**

**Capability of CORDEX RCMs in simulating extreme rainfall events over South Africa**

S. Abba Omar (1); A. Babatunde (2)

(1) University of Cape Town, Environmental and Geographical Science, Cape Town, South Africa; (2) Climate Research Analysis Group (CSAG), Department of environmental and geographical science, university of cape town, Cape Town,
In South Africa, extreme rainfall events often lead to widespread destruction, damage infrastructure, displace communities, strain water management and even destroy lives. Past extreme rainfall events in coastal cities of South Africa have highlighted the need for better understanding and management of extreme rainfall events. This study applies satellite data, Remote sensing and Geographical Information System (GIS) methodologies to assess the environmental and societal implications and the risk of extreme rainfall events in coastal areas. The study found that extreme rainfall events could be related to changes in the climate system and sea surface rise on coastal cities of South Africa. The results show that extreme rainfall events are occurring more frequently in coastal cities, which could lead to increased risk of flooding and coastal erosion. The study highlights the importance of integrated approaches to manage extreme rainfall events in coastal cities of South Africa.

The Climate Expectancy: a resolute parametrical approach to redefine the climate

V. Cailliez (1)  
(1) Chambre d’Agriculture de la Creuse, GUERET, France

1) The 30-year average, a largely outdated concept:
Since the climatic break (or powerful acceleration) that happened throughout the world in the late 70s, temperatures are following a steep slope. Considering the Whole World Simulation experiments (see IPCC AR5), this trend is not going to slow down, to speak gently. So, we can no longer ignore that the mathematical operation of averaging applies not only on values but also on time, when used on a chronological series. If we don’t renew the definition of climate normality, we will be using the 30-year average of 1981-2010 (i.e. the 1991气候 expectancy) until 2021, when the 30-year average of 1991–2020 is to be calculated and released. What was tolerable in times of slow and weak fluctuations is becoming unacceptable in a situation where a strong trend is at work from +0.3°C to +0.5°C per decade in France since the climatic break, for instance.

The link with climate extremes is obvious. An extreme is qualified by its distance to normality. If we define the normality better, we define better what is away from it.

2) Redefining the climate:

The World Meteorological Organization (WMO) classical definition of the climate can be written: observation time series = 30-year average + anomaly time series

The proposition is to refine the 3 terms of the equation by an homogenization of the observed meteorological data, followed by a separation between the random part of the series (replacing the anomaly) and the organized part which is, in fact, the climate expectancy. The underlying idea is to consider that a ‘real’ anomaly in a time series should be what is totally unexpected, and so, what is part of the random series

3) Organizational analysis:

The purpose is the separation of the long-organizational orientations (trend, cycles...) from the short-term ones (peristence...). Considering the long-organizational terms, we can write:

Par(t) = (a*t+b)+Amp1*sin(2Πt/P1+Phas1)+Amp2*sin(...) +...+ParWLTO(t)

where Par(t) is the homogenized series and WLTO means Without LongTerm Organization.

The short-term organization is treated in an auto-regressive process:

ParWLTO(t) = A1.ParWLTO(t-1)+...+Akmax.ParWLTO(t-kmax)+ParWSTO(t)

where Ai are the auto-regression coefficients and kmax is the (maximum) horizon of significant persistance. WSTO means Without long term and ShortTerm Organization.
We can now easily deduce the expression of the climate expectancy \( \text{ClimPar(t)} \) :
\[
\text{ClimPar(t)} = \text{Par(t)} - \text{ParWSTO(t)}
\]

On this expression, it is easy to figure out that we can have a different value of the climate expectancy on each observed data till the last one. The compatibility with the classical WMO definition is achieved simply by centering ParWSTO(t).

The randomness of the ParWSTO(t) series can be verified with statistical tests like the random tests. It happens that the separation between organized and random parts is essential. We experienced this with 30-year to 60-year long daily datas of maximum and minimum temperatures, located in the central region of France called Limousin.

Because the ParWSTO(t) series is a random series (or very close to), it can be regenerated by a random number generator. The shape of the random distribution is adjusted dynamically and parametrically to the observed one by analysing the organization of the variance, skewness and kurtosis of ParWSTO(t).

The upgrade of the determination of climate extremes is the result of the whole process which can be summarized as a separation between organized and random variability.

4) Biding farewell to the 30-year average ...

On one side, the 30-year average is an easily explained notion, which needs only simple calculations and is universal. To abandon it will be indeed a difficult human and social process. On the other side the climate expectancy is a very open concept, delicate to understand at first sight and that can lead to long and uneasy calculations. However its integration into the toolbox of climatologists has to be started soon because of the strength and the inertia of the global warming phenomenon. Its usability at very different scales of time (from hourly to centennial dates at the least) should facilitate a rapid consensus.

**P-1113-04**

Climate change and extreme weather events in Mediterranean Sea: studies with WRF atmospheric model

G. Emmanouil (1); M. Vlachogianni (1); A. Sfetsos (1)

(1) Demokritos, Athens, Greece

Extreme weather events are becoming more frequent the last years. This fact along with its relation to the possible climate change, are two major issues of scientific study. In this work, WRF–ARW atmospheric model is used to simulate extreme weather conditions in Mediterranean Sea, focusing in the Greek peninsula. Sensitivity tests with different model configurations will be presented, as well as evaluation of the in situ observations. The results show good agreement with observations and prove to be a very useful tool for studying, forecasting and trying to limit down the consequences of such events.

**P-1113-05**

Extreme Rainfall Events in Asia: Projected Changes and Uncertainties

J. Freychet (1); A. Duchez (2); CH. Wu (1); HH. Hsu (1); CA. Chen (1); A. Forryan (2); B. Sinha (2); JJM. Hirschi (2)

(1) Academia Sinica, RCEC Research Center for Environmental Change, Taipei, Taiwan; (2) National Oceanography Center (NOC), Southampton, United Kingdom

Extreme precipitation (and drought) are one of the main concerns for society and environment, because they can lead to severe social and economic impacts (lack of water). During the wet season, atmospheric moisture is expected to increase, and could thus create more favorable conditions to trigger extreme rainfall. However, the change in dynamics can also play a major role in the change of distribution of precipitation. The modification of the land–sea thermal gradient, the vertical structure of the atmosphere, or the latent heat released by the precipitation, can all impact the large scale circulation, and thus the rainfall distribution.

In this study, focused on the East Asia region, we analyzed the results from two high resolution models (HIRAM-C192 and HadGEM3–GC2), and from the CMIP5 ensemble, to investigate the projected change in extreme rainfall events (either extreme precipitation or long drought). The role of the SST is also investigate. HadGEM3–GC2 is fully coupled with ORCA025, while HIRAM-C192 is forced by prescribed SST. The SST forcing for this model is determined by a cluster analysis from the CMIP5 projection. Three main patterns of SST are used, providing three different projections for this future. With this correlation with the dynamics to explain the interannual variability of the extremes events.

In both CMIP5 ensemble and high resolution models the signal of extreme precipitation strongly increase during the summer. On the other hand, the signal on the drought spell is not clear. HadGEM3–GC2 show a decrease during winter of East Asia, while the HIRAM-C192 show an increase during this same season. It could be due to a difference of sea–land contrast. The East Asia 200 hPa jet intensity impacts significantly the variability of extremes precipitation, when the summer 850hPa winds show a strong correlation with the drought over East Asia. The results on CMIP5 ensemble also show a significant impact of the change in vertical motion (with a tendency to slow down), that could act as a counterbalance to increase of atmospheric moisture. But large uncertainties remain between different models, and impact strongly the confidence on the extreme projection.

**P-1113-06**

Climate change impacts on social well-being of fishers' communities in the Bangladesh Sundarbans

MM. Islam (1)

(1) Sylhet Agricultural University, Department of Coastal and Marine Fisheries, Sylhet, Bangladesh

Social well-being concept has garnered much interest in recent years as a multi-dimensional, holistic approach to understand and measure progress and problems. Though the concept of social well-being has operationalized across different disciplines, there are very few studies using this concept to show how climate change is affecting social well-being of fishing communities. To fill this knowledge gap, this study employs social well-being approach to study the impacts of climate change on the livelihoods of fishers in the Sundarbans. Qualitative data collection tools were employed; a semi-structured questionnaire was used to collect the empirical data from four fishing communities. Given that, in recent past two consecutive cyclones– Sidr (hit Bangladesh coast on 15th November, 2007), and Aila (struck Bangladesh coast 25th May, 2009) affected a major part of the Sundarbans mangrove ecosystem with great devastation. In this case, in terms of other environmental degradations such as saline water intrusion, occasional droughts as well as degraded resources base of the fisher. Thus, ongoing environmental changes in the Sundarbans and its effects on the communities provide a suitable setting to study the impacts on climate changes on the well-being of the residing population. Following the WHO framework of wellbeing, social well-being has three dimensions, material, subjective and relational that together constitute human welfare. Cyclones Sidr and Aila caused loss of different 'material' values for the fishing communities in several ways. Rising tidal waves, associated with cyclones washed away productive assets, housing, and standing crops in the field, employment opportunities in alternative occupations were also severely squeezed, that altogether rendered in income loss of the communities. Immediate aftermath of cyclone Aila, most fishers took shelters in makeshift built on embankments that severely degraded their standard of living. Increased salinity and water pollution caused acute crisis of drinking water and loss of biodiversity that reduced overall environmental quality of region. Many fishers expressed their shocks, fears after seeing that rising water washed fishing site, that in the eyes of their eyes. Living in constant economic hardship, depending on external supports for survival for longer period, school drop out and increased child labour undermined fishers' aspirations and confidence for a secured future. In case of relational values, ‘social cohesion’ of fishers' communities traditionally served as buffer during the period of crisis. However, individual competition to receive relief at the cost of others' interest negatively affected the community bonding and dispelled social capital to certain extent. The
responses from the government mostly gave emphasis on restoration of the affected communities. Following this new understandings through social well-being lens, the present study submits for a more holistic, more responsive policy making in Bangladesh by taking consideration into multiple dimensions of human welfare that are affected by climate change impacts.

P-1113-07

Characterization of extreme rain events and assessment of Regional Climate Models in Morocco

K. Khomsi (1) ; M. Gil (2) ; M. Sinan (3) ; M. Snoussi (4)  
(1) Direction de la Météorologie Nationale, Casablanca, Morocco; (2) University Montpellier 2, HSM/IRD, Montpellier, France; (3) Ecole Hassan II des Travaux Publics, Casablanca, Morocco; (4) University Mohammed V-Agdal, Faculty of Sciences, Rabat, Morocco

At a global scale, more than half of the costliest disasters are weather related and our planet is facing more devastating extreme events mainly those related to rain. In Morocco, the floods between the 21st and the 25th November 2014 in the south of the country had caused the death of 32 people. In Casablanca, the flood of the 29th – 30th November 2010 had caused enormous human and material losses. In the province of Settat, the flood of the 23rd November 2014 killed two people, displaced at least eight people and flooded several industrial units and Douars in the region, adding to many other tragedies in the flood areas. Also in Ourika, the floods of the 17th August 1995 had caused the death of 6 people, flooded 2300 houses, damaged 2000 cars and 200 damaged cars and other property damage. Thus, there is a real need for understanding and anticipating weather extreme events mainly those related to intense rains, that may leads the way in risk assessment and development of mitigation strategies.

The aim of this work is to characterize the frequency and the trends of rain extreme events and to assess simulations of regional climate models in these extreme events in the watersheds of Tensift and Bouregreg (Morocco), during the last decades. First, the work analyzes the observed trends in daily rainfall and the SPEI at 23 stations and the effects of very rare and exceptional rain events, using percentile–sampling thresholds, and studies the trends of their frequencies. Finally it evaluates an ensemble of regional climate models from the European project ENSEMBLES, with regard to the found trends in order to recognize models that best describe observed rain regime, in the studied catchments.

P-1113-08

Relationship between the Tropical South Atlantic SST and drought over West Africa from CORDEX

NAB. Klutse (1) ; A. Babatunde (2) ; M. Adeniyi, (3) ; F. Rachid

(1) Ghana Atomic Energy Commission, Remote sensing, gis, climate, ghana space science and technology institute, Accra, Ghana; (2) University of Cape Town, Environmental And Geographical Science, Cape Town, Western, South Africa; (3) University of Lagos, Department of physics, Ibadan, Nigeria, Federal Republic of; (4) University of Cape Coast, Department of physics, Cape Coast, Ghana

Droughts in West Africa are not only an environmental problem but also a social and economic concern. However, drought research has not obtained the necessary attention in West Africa. Moreover, the dynamics of West African drought is not fully understood and among the studies that have considered droughts of West Africa, only a few have considered the link between Tropical South Atlantic (TSA) Sea Surface Temperature (SST) and drought over West Africa. In this study, we look at how CORDEX models represent the relationship between the TSA SST and drought precipitation and temperature over West Africa. Studies on drought done over West Africa used only precipitation index in Standardized Precipitation Index (SPI) to measure drought index. The use of precipitation alone is inadequate to give information about drought as evapotranspiration has a direct influence on drought. We recognize that evapotranspiration is an important process of water loss. Here, we use the Standardised Precipitation Evapotranspiration Index (SPEI) where evapotranspiration is included in the calculation of the drought index.

P-1113-09

Drought Hazard Analysis over India and Its Impact on Climate Using Applying Multivariate Technique for Composite Indicators

P. Kumar, (1); K. Swati (2)  
(1) Banasthali University, Remote sensing, jaipur, India; (2) Banasthali University, Remote Sensing, Tonk, India

Drought being complex and least understood disaster affects multidimensional parameters of social and economic structure of society. It is said to be hydro-meteorological disaster having prolonged period of below average precipitation causing drought whose severity is largely determined by the amount of rainfall. The objective of this study to carryout drought hazard analysis in India with a combination of drought indices in geospatial environment using meteorological drought hazard analysis has been carried out effectively by the generation of Drought Hazard Index (DHI). Meteorological drought hazard analysis was performed by analyzing rainfall and its distribution pattern and drought occurrences. The current study of this research is to develop a composite index capturing spatial variations of drought hazard by taking into account the spatial and temporal occurrence of meteorological drought and to map the drought hazard in India. The present research involves generation of drought hazard index formed by compilation of individual indicators based on meteorological drought hazard index which is further used for the analysis of namely meteorological drought hazard in the country India. The study uses Climate Precipitation Center (CPC) rainfall time series at 1°x1° km grid for south west monsoon season (June–September) for 12 years 2001–2012 shown in Figure 1. DHI proposed in this study is a major initiative towards generating hazard indices for disasters with the composite index approach. DHI is the only known approach to capture the drought pattern in the country by capturing the spatial variations in drought hazard across India. The DHI has thus effectively captured the spatial variations in drought hazard across India. The spatial patterns of drought hazard are reasonable and justify the strength of the index. The procedure for generating DHI can be further improved by adding more number of indicators. The strengths of the methodology are using a composite index method, analysis in spatial perspective, inclusion of a wide range of inputs and covering a large geographic area. Indicators selection and weights generation are the possible areas for further work.

P-1113-10

Determining climate indicators to assess the impact of extreme weather events on road accidents in Hungary

M. Lakatos (1) ; E. Vincze (1) ; Z. Bihari (1) ; T. Szentimrey (1)  
(1) Hungarian Meteorological Service, Climate Department, Budapest, Hungary

The Special Report of IPCC on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (2011) concluded that there is evidence from observations gathered since 1950 of change in some extremes. A set of climate indices are used in several projects on climate change as prevailing indicators of changes in extremes.

The main focus of the presentation is preparing climate indicators to impact and vulnerability assessment of road accidents, as critical infrastructure, within extreme weather events. In wintertime periods based on existing dataset of the National Adaptation Geographical Information System (NAGIS) in Hungary. The daily grid for period 1961–2010 in 0.1° spatial resolution for several basic meteorological variables and climate indicators were created in CARPATHCLIM (Climate of Carpathian Region) project is integrated to the NAGIS system for the territory of Hungary. The common used methods and software in the CARPATHCLIM project was the method MASH (Multiple Analysis of Series for Homogenization; Szentimrey) for homogenization, quality control, completion of the observed daily data series; and the
method MISH (Meteorological Interpolation based on Surface Homogenized Data Basis; Šved, Brewery and Bihari) for gridding of homogenized daily data series. It is a relevant climate database for studying climate extremes and climate change in the region.

Different climate indicators are defined and quantified to mapping of exposure and sensitivity such as zero crossing days, precipitation amount in a specific period, ice days, snow days, wind speed, cold/wet days, daily mean temperature < 25th percentile, and daily precipitation > 75th percentile for example. These climate indicators are the inputs to impact studies that will be developed through the integration of the exposure and sensitivity mapping layers to the NAGIS system. Mapping of exposure will be based on measurement data and climate modelling results of Hungarian Meteorological Service (OMSZ), while the exposure and impact data recorded at the central body of disaster management will serve as a basis for sensitivity mapping. Among others these climate indicators will be used to assess the vulnerability due to climate change, and to develop the development of adaptation strategies and objective decision making.

P-1113-11

Changes in nature of extreme rainfall in southern Africa

C. Lennard (1)

(1) University of Cape Town, Climate System Analysis Group, Cape Town, South Africa

Extreme rainfall, usually expressed through local or regional weather events, is driven by synoptic-scale forcings as well as other factors like moisture availability, lapse rate etc. rainfall and especially small-scale extreme rainfall associated with convection is poorly simulated by numerical models (general circulation models – GCMS) and regional climate models (RCMs). However, numerical models are able to simulate large-scale circulation states so in this study we characterize circulation states to investigate projected changes in extreme rainfall over Southern Africa.

Downscaled evaluation and projection data from two CORDEX regional models and four global models were examined and changes in the occurrence of rainfall and extreme rainfall investigated in three sub-regions over southern Africa. Synoptic states associated with extreme rainfall were identified in each region. Over the evaluation period we found that the regional models and BMEs adequately capture the general rainfall characteristics over the region but did not capture the characteristics of extreme rainfall well. However, synoptic states associated with rainfall and extreme rainfall were captured and characterized.

In the near-term (2036–2065) and far-term (2066–2099) under both RCP4.5 and RCP8.5, synoptic states that are associated with drier conditions are projected to increase, while synoptic states that enhance precipitation are projected to decrease over time. Furthermore, the synoptic states associated with extreme precipitation are projected to increase.

Given the current threat posed by extreme rainfall in the region these results speak directly to the necessity to develop effective and implementable adaptation strategies to reduce the impact of extreme rainfall on vulnerable communities.

P-1113-12

Summer temperature extremes over Europe obtained from an ensemble of regional climate models

S. Lidija (1); I. Gütter, (1); K. Cindrić, (1); D. Branković, (1);
(1) Meteorological and Hydrological Service, Department for Climatological Research and Applied Climatology, Zagreb, Croatia

European summer temperature extremes from simulations of six EURO-CORDEX regional climate models are analysed for the 20-year period, 1989–2008. The models were driven by ERA-Interim reanalysis at 50 and 12.5-km horizontal resolutions. Three categories of extreme temperature indices – absolute, percentile and duration – are derived from daily data. The results are compared with extreme temperature indices calculated from the gridded daily E-OBS data over Europe and are in the first instance compared to other climate indicators and model simulations. The indices are derived from daily observations at 20 Croatian meteorological stations. The ensemble spread is large, but the biases at 12.5-km simulations are smaller than at 50 km. When compared with validated data, model-simulated temperatures and their percentiles are mostly overestimated over southern Europe and underestimated over northern Europe. Over Croatia, spatial distribution of indices at 12.5 km is closer to observed distribution than at the 50-km resolution.

P-1113-13

Standardized Precipitation Index (SPI) and Its Use to Assess Drought Occurrences in Cameroon over Recent Decades

F. M'kankam Kanga (1)

(1) Université des Montagnes, Bangangté, Cameroon

The standardized precipitation index (SPI) is computed and analyzed using 55 years of precipitation data recorded in 24 observation stations in Cameroon along with University of East Anglia Climate Research Unit (CRU) spatialized data. Four E-OBS data over Europe and (Garpact, Weibull, and lognormal) are first fitted to data accumulated for various time scales, and the appropriate functions are selected on the basis of the Anderson-Darling goodness-of-fit statistic. For short time scales (up to 6 months) and for stations above 10°N, the gamma distribution is the most frequent choice; below this belt, the Weibull distribution predominates. For longer than 6-month time scales, there are consistent patterns of fitted distributions. After calculating the SPI in the usual way, operational drought thresholds that are based on an objective method are determined at each station. These thresholds are useful in drought–response decision making and objective decision making.

P-1113-14

Analysis of extreme temperature indices of long-term homogenised temperature series in South Africa

M. Nxumalo (1); A. Kruger, (2)

(1) South African Weather Service, Climate department, Pretoria, South Africa; (2) South Africa, Climate department, Pretoria, South Africa

Homogenized data reduces the risk of significantly biased results in historical climate trend analysis. This study utilises for the first time long-term homogenised maximum and minimum daily temperature data sets for South Africa, spanning from the period 1931 to 2014. Previous extreme temperature trend analyses for South Africa only extended to 2009. This makes the current analyses significant in terms of the period of analysis, but also the number of stations that could be utilised. Whereas previous studies covered the analysis of the time series of fewer than 30 stations combinations of data from different stations in single time series through homogenisation increased the number of time series to 36. The time series were analysed using the extreme temperature indices developed by the WMO-ETCCDI team, which makes it possible to compare the results to other analyses across the world. Examples of the index trends analysed are the annual number of cool days, annual number of warm days, Diurnal temperature range, annual maximum and minimum temperatures, warm and cold nights and annual maximum warm spells, amongst others. This analysis forms part of the ongoing study in historical temperature trends in South Africa from in situ measurements, by the South African Weather Service.

P-1113-15

Characterizing and understanding the
Changes in the occurrence of cold and heat waves in France toward the end of the century assessed using a stochastic model to downscale climate model simulated temperature

S. Parey (1) ; T. Hoang (1)
(1) EDF/R&D, MFEF, Chatou, France

As cold and heat waves have a major impact on society and economy, recent changes and their potential future developments are currently studied in climate change scenarios for different parts of the world. This study may be viewed as another of such studies, but its originality lies in the adopted methodology. The aim here is to assess how cold or heat waves frequencies can also be obtained for climate model simulations and thus the significance of the changes can be more robustly assessed. The results obtained with two different climate models (CNRM-CM5 and IPSL-CM5A-MR) and two future periods, the first and second half of the 21st century will be presented.

P.1113-17
Study of Extreme Rainfall Events over Odisha using observation and simulation

S. Payoshni (1) ; KC. Couda (2) ; P. Goswami (3)
(1) CSIR 4PI, BANGALORE, KARNATAKA, India; (2) CSIR 4PI, Cemp, BANGALORE, KARNATAKA, India; (3) CSIR FOURTH PARADIGM INSTITUTE (FORMERLY CSIR CMMACS), Cemp, BANGALORE KARNATAKA, India

The state of Odisha lies in the eastern part of India with a broad coast line of around 480 km. The climate of the state fully depends on the Indian summer monsoon and being the coastal state always the disaster due to hydro meteorological events like tropical cyclone, extreme rainfall events (ERE) and flood etc. are important to monitor and model for the real time mitigation and disaster management. In this study first the extreme rainfall analysis is being carried out using the rainfall data from multiple sources like the India Meteorological Department (IMD) daily gridded data, APHRODITE and Tropical rainfall measurement mission (TRMM) data. Firstly the ERE defined with the criteria of a grid point receiving 10cm or more rainfall per 24 hour, are counted over the continental part of Odisha state domain (18-22.5 on, 82-87 oe) at the daily scale for the period 1951 to 2014. The inter annual variability in the number of ERE over the state are presented and which clearly shows there is an increasing trend in the ERE about 0.2 event/year, because there is a robust trend of the ERE in the second part the ERE distributions are being analyzed and clearly indicates there is increase in the ERE over the south, central and eastern part of Odisha while the trend is normal in the northern part. The possible impact of climate change is also quantified. To simulate the ERE the Mesoscale Meteorological Research Institute, Japan Non Hydrostatic Model (NHM) is calibrated for the Odisha region and was used to simulate the ERE and the model is well capable of simulating the EREs before 48-72 hours. Some sensitivity studies also carried out with the model for the optimized configuration of the model for the meso scale forecasting of the EREs over Odisha. This model configuration and the observational study can be used for the investigation of the ERE mechanisms in particular over Odisha region and the medium range forecasts can be used for flood warning, water management, disaster management etc. for the state of Odisha.

P.1113-18
Uses and limits of thermal indices: the case of Sahel

S. Rome (1) ; V. Moron (2) ; B. Oueslati (3) ; B. Pohl (4) ; B. Fontaine (4) ; B. Diedhiou (5)
(1) Université Grenoble Alpes, LTHE UMR 5564 UJF–CNRS–IRD, Grenoble, France; (2) Aix–Marseille Université, CEREC UM 34 CNRS, France, Geography, Aix-en-Provence, France; (3) Centre de Recherches de Climatologie–BIOGEOSCIENCES, Université de Bourgogne, Dijon, France; (4) Centre de Recherches de Climatologie–BIOGEOSCIENCES, Université de Bourgogne, Dijon, France; (5) Institute of Research for Development (IRD), LTHE – University Grenoble Alpes, Grenoble Cedex 9, France

Our main goal here is to analyse extreme heat waves and the standard deviation, these 100 simulations are also used to reconstruct 100 time-series from each climate model of simulation for different periods and greenhouse gas emission scenarios. The climate model biases are corrected by reconstructing the future seasonalities as the observed ones, to which the future changes given by the climate models are added (S0f = S0o + (Sf - Smp)). S0f = S0o*SVf/Svmp where subscripts o is for observation, f for future and p for present). Then, the full climate model non parametric trends in mean and standard deviation are considered. In this way, distributions of the cold or heat waves frequencies can also be obtained for climate model simulations and thus the significance of the changes can be more robustly assessed. The results obtained with two different climate models (CNRM-CM5 and IPSL-CM5A-MR) and two future periods (RCPI.5 and RCPB.5) and two future periods, the first and second half of the 21st century will be presented.

Future changes of extreme events of sea cooling in the Black Sea region in winter period of end of XXI century

A.Savchenko (1)
(1) Marine Hydrophysical Institute of NAS of Ukraine
Interaction of atmosphere–ocean, Sevastopol, Ukraine

The study of climate change at the end of the XXI century with increasing human intervention around the world is important and necessary. In particular, it is argued that the unprecedented magnitude of the positive trend in air temperature in the last century, largely due to the concentration of greenhouse gases in the atmosphere associated with human activities. Moreover, this warming will continue in this century, and by the end of the century it will be 1–5 °C. Meanwhile, the spatial resolution of global models, despite the continuous improvement remains insufficient to display a regional atmospheric circulation. The mesoscale and dynamical downscaling takes an additional argument in regions with underdeveloped network of meteorological stations and difficult terrain. In the current global climate models do not take into account the Crimean Mountains, the Caucasian Mountains height not exceeding 2 km, and the Black Sea is posed less than 10 points calculation area. In this study, we used input data of global model INMCM4, which is a joint in international project CMIP5. Experiment of downscaling was carried out for area Black–Caspian Sea region to further revised data, i.e. the transition from large-scale calculations of global fields to regional estimates. To obtain a set of regional characteristics (temperature, turbulent heat fluxes, etc.), directly with the influence of regional factors with a spatial resolution of 25 x 25 km. Thus, for the Black Sea region were calculated turbulent heat fluxes for winter 2071–2100 (RCP8.5). By control period used a data set of observations for the period 1971–2000 years. In the Black Sea basin was selected region's largest winter heat fluxes from the sea surface, which in the north-western part of Black sea. It is interesting that in the selected area of river runoff about 80% of the total annual flow into the Black Sea. According to the scenario RCP8.5 average temperature in winter over the Black Sea basin will rise by 2.2 °C at the end of XXI century. The following integral characteristics of the north-western shelf of the Black Sea are in the area of the sea bounded by the 44 – 47°N and 26 – 34°E. In the future heat fluxes of winter periods will change as follows: sensible heat flux will decrease by 3%, and latent heat flux will increase by 22% compared to the control period. Also Bowen ratio was calculated for the average winter values that will decrease in the future, but it is interesting in the control period. This ratio was calculated in order to look at the share of sensible and latent heat in the total heat flux (sensible heat flux + latent heat flux = total heat flux) and look at their qualitative changes. Most interesting were the calculations of extreme events P = 95% (5% of winter days with the largest values of total heat flux of the winter period) and their change in the future period. Thus it appears that the total flux extreme heat rise by 40%. It was also interesting to see the changes in the synoptic situation during extreme cooling P = 95% of north-western part of Black Sea in the winter, where a total heat flux used to build composites. Composite indices show that the atmospheric situation in Europe have been identified 2 main types (clusters). So the first type – an anticyclone on the Baltic sea, and the second type of synoptic situation – a cyclone in the district of the Caspian Sea. In the future period the number of extreme events P = 95% in each cluster was approximately 50% to 50%. And compared to the control period there was little over 20% and second type almost 80% of all events P = 95%. That is, it can be concluded that the change not only the quantitative characteristics of extreme cooling, but also qualitative characteristics of sea cooling. The greatest danger in the future period(2071–2100) in Black Sea region are extreme events for P = 99%, while increasing total flux extreme heat rise by 22% compared to the control period and result in potential losses in fishing, oil (gas) industry, agriculture and the other in this region. Thus these results require further verification and analysis of possible risks in the future for the economy of the Black Sea region.
ABSTRACT BOOK

P-1113-20

Climatological analysis of trend of rainy days in Bangladesh using Mann Kendall Test

MR. Uddin (1); J. Begum (2); S. Ahmed (3)
(1) Bangladesh University of Engineering and Technology, Department of physics, Dhaka, Bangladesh; (2) Southeast University, Department of textile engineering, Dhaka, Bangladesh; (3) Gono Govt. College, Department of physics, Comilla, Bangladesh

The impact of climate change on rainy days has received a great deal of attention by scholars worldwide. Many studies have been conducted to illustrate that changes in annual rainy days is becoming evident on a global scale. Bangladesh is likely to be one of the most vulnerable countries to climate change. This paper focuses on detecting the trend of rainy days for 13 Bangladesh Meteorological Department rain gauge stations using Mann Kendall test, which was run at 5% significance level during the period 1950–2009. Seasonal and yearly trend of rainy days (greater than 01 mm/day) are studied. Variation of three threshold rainy days named: Moderated Heavy (22–44 mm/day), Heavy (45–88 mm/day) and Very Heavy (greater than 88 mm/day) are also studied. The country is divided into two regions named: wet region and dry region. All the stations showed increasing trend of rainy days except in Srimongal. The trend of Dhaka, Cox’s Bazar, Srimongal and Chittagong stations are not statistically significant. All the four seasons (winter, pre-monsoon, monsoon post-monsoon) showed statistically significant increasing trends except post-monsoon. The country’s averaged threshold rainy days also showed statistically significant increasing trend except Very Heavy rainy days. The yearly rainy days indicate statistically significant increasing trend. The yearly rainy days in the wet region (122 days) were higher than that of dry region (105 days). The wet (dry) region showed negative (positive) trend of rainy days during 1950–1979 whereas wet (dry) region shows upward trend during the variation of rainy days during 1980–2009. The country’s averaged threshold rainy days showed negative trend during 1950–1979 and positive trend during 1980–2009. These changes indicate that the climate of Bangladesh is changing. The yearly averaged increase of rainy days was 0.35 days.

P-1113-21

Climate Change Signal in the 2012 Central U.S. Record (Flash) Drought

SSY. Wang (1)
(1) Utah State University, Climate Center, Logan, Utah, United States of America

The summer drought of 2012 in the central United States is instructive regarding one unique feature, that is, its rapid intensification during the early summer, evolving over a mere month from moderate to severe status. The timing of this drought’s rapid intensification coincided with a subseasonal feature of widespread drying. The seasonal transition from June to July saw precipitation in the central U.S. decrease by about 25%, and this precipitation decrease is observed to have intensified since 1979. Such an intensification could enhance spring drought occurrences in the central U.S., where conditions evolved quickly from_finished. Normal to exceptional dry, likely within a mere month from June to July. In this study, various atmospheric and land reanalysis datasets were analyzed to examine the trend calculated from 1979 to 2012 in the June–to–July seasonal transition. It was found that the change in precipitation deficit was accompanied by increased downward shortwave radiation flux and tropospheric subsidence, enhanced evaporative fraction, as well as all areopyraneous boundary layer height. The change in the tropospheric circulation encompassed an anomalous ridge over the western U.S. and a trough on either side; this wave–form circulation pattern is known to induce dry conditions in the central U.S. Such trends in the June–to–July seasonal shifts in precipitation, surface drying, and tropospheric circulation could have intensified and accelerated drought that took place in spring. The knowledge gained can be used to anticipate the evolution of spring onset of drought into the summer.

P-1113-22

Extreme North America Winter 2013–15: California drought and cold East Coast

SSY. Wang (1); JH. Yoon (2); R. Gillies, (3)
(1) Utah State University, Climate Center, Logan, Utah, United States of America; (2) Pacific Northwest National Laboratory, Department of energy, Richland, WA, United States of America; (3) Utah State University, Logan, UT, United States of America

The ongoing California drought was initiated by an anomalous high–amplitude ridge system in the winter of 2013–2014. The anomalous ridge was investigated using reanalysis data and the Community Earth System Model (CESM). It was found that the ridge emerged from continual sources of Rossby wave energy in the western North Pacific starting in late summer and subsequently intensified into winter. The ridge generated a surge of wave energy downwind and deepened further the teleconnections over the United States. The dipole and associated circulation pattern is not linked directly with either El Niño–Southern Oscillation (ENSO) or Pacific Decadal Oscillation; instead, it is correlated with a type of ENSO precursor. Multi–model analysis using CMIP5 model outputs indicated that the connection between the dipole and ENSO precursor has become stronger since the 1970s, and this is attributed to increased greenhouse gas loading, as simulated by the CESM. The ridge is a traceable anthropogenic warming footprint in the enormous intensity of the anomalous ridge during winter 2013–2014 and the associated drought. When projecting for the future, the large–membrane ensemble mean suggests increases in fire counts and extreme drought occurrences, both of which are increasingly linked to the ENSO cycle.

P-1113-23

Early and late winter cold spells over the Euro-Mediterranean region

E. Xoplaki (1); A. Toreti (2); J. Luterbacher (1)
(1) Justus–Liebig–University Giessen, Geophysics: Climatology, Climate Dynamics and Climate Change, Giessen, Germany; (2) European Commission, Joint Research Centre, Ispra, Italy

Temperature extremes have a strong impact on ecosystems, societies and economies; for instance in terms of impacts on agriculture, human health, energy consumption among others. Warm summer extremes and their impacts, i.e. summer heat waves, have extensively been investigated and characterised in several studies focusing on either recent past–current time or climate projections for the next decades. Less efforts have been, instead, devoted to cold spells occurring in the Euro–Mediterranean region, although also these extreme events can have significant impacts especially in a future warmer climate. Especially for the European societies, sensitivity to cold weather is greater than the northern, cooler regions, while mortality is found to increase to a greater extent with a given fall in temperature in regions with warmer winters. This study aims at characterising future changes in the occurrence, intensity, and duration of cold spells and their spatial variability over the Euro–Mediterranean region. The focus is on early and late cold season events (December and March, respectively). The consequences of the occurrence of a presiding warmer autumn (winter for the late season events). Mid– and late 21st century potential changes are investigated by using the recently released Euro–Cordex regional climate simulations both under the mid-range mitigation emission scenario RCP4.5 and the high emission scenario RCP8.5.
K-1114-01

Short Lived Promise? Short-lived climate pollutants, cumulative carbon and emission metrics

M. Allen (1)
(1) University of Oxford, School of geography and the environment, Oxford, United Kingdom

The relative priority given to reducing carbon dioxide emissions versus other forms of anthropogenic climate pollution, such as the Short Lived Climate Pollutants (SLCPs) methane and soot, could be a significant issue for many countries in the preparations for COP21. The decision to allow countries to adopt their own metrics to add up the role of different gases in their contributions to the overall greenhouse gas forcing highlights the need for clarity on these issues. This talk will review the findings on cumulative carbon and emission metrics in the IPCC 5th Assessment, and present a new Policy Brief from the Oxford Martin School, with the same title, that discusses and elucidates these issues.

Any strategy to prevent dangerous anthropogenic interference in the climate system must limit cumulative emissions of the main long-lived climate pollutant, carbon dioxide (CO2). To limit the warming they cause to 2°C, for example, CO2 emissions must be limited to a cumulative budget of about one trillion tonnes of carbon, over half of which has already been released. That said, other climate drivers are likely to contribute to peak warming, and hence reduce the carbon budget consistent with 2°C of total anthropogenic warming. Current emissions of both CO2 and SLCPs also affect the rate and magnitude of climate change over the next few decades, although it is important to note that the climate benefits of reduced emissions on these short timescales could be comparable to, and hence potentially outweighed by, natural climate variability, particularly on regional scales.

Reductions in SLCP emissions could be achieved at relatively low cost and with substantial co-benefits but, I will argue, implementing these reductions immediately would have a relatively small impact on warming unless CO2 emissions are substantially reduced at the same time. Hence any decisions on policy priorities between CO2 and SLCPs, and any country’s choice of emission metric to relate them, represents in essence a matter of intergenerational prioritisation: Advancing measures to reduce SLCP emissions could provide some climate benefit to the current generation through reduced warming over the next few decades, while immediate reductions in CO2 emissions also deliver a more substantial climate benefit to future generations.

Any emission trading system or climate policy that addresses emissions of several different greenhouse gases together in a single ‘multi-gas basket’ requires some form of metric to specify what a given amount of one greenhouse gas is ‘worth’ in terms of another. The choice of metric to compare the impact of emissions of methane and other SLCPs with the impact of CO2 depends on the timescale of interest. If the policy goal is to limit peak warming, it also depends on the ambition and success of future mitigation measures.

The standard ‘100-year Global Warming Potential’ metric (GWP100) provides (despite its name) an approximate indication of the relative importance of emissions of different gases to the increase in global temperatures over the next 100 years. GWP100 is therefore a measure of impact on peak warming and if only if temperatures are expected to be approaching stabilization within 40 years, for which CO2 emissions need to approach zero on a comparable timescale.

As long as CO2 emissions continue to rise, policies that allow SLCP measures to be exchanged, traded or offset against CO2 emission reductions using GWP100 over-value the impact of SLCP measures on peak warming and hence risk discouraging the CO2 emission reductions that are required to stabilize temperatures. Replacing GWP100 with a different metric would not solve this problem because any metric that is suitable for long-term impacts would be misleading for short-term impacts and vice versa. Using a metric that changes over time would help, but introduces greater complexity and uncertainty.

Rather than discussing a change of metric within a single ‘multi-gas basket’ framework, policymakers should focus instead on introducing additional instruments, safeguards or measures to ensure that cumulative emissions of CO2 are limited to an overall budget consistent with meeting the 2°C goal. A simple precaution would be to avoid trading or offsetting between CO2 and SLCP emission reductions until global CO2 emissions are falling fast enough to allow a robust and realistic assessment of the remaining time to peak warming.

O-1114-01

The changing face of global fossil fuel carbon dioxide emissions

R. Andres (1); T. Boden (2)
(1) OAK RIDGE NATIONAL LABORATORY, LOS ALAMOS, NM, United States of America; (2) OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, TN, United States of America

Global fossil fuel carbon dioxide emissions have been persistently increasing for the last 250 years. This increase is a primary driver of the atmospheric disequilibrium impacting and changing atmospheric, terrestrial, and oceanic systems.

The Carbon Dioxide Information Analysis Center (CDIAC) at Oak Ridge National Laboratory (ORNL), U.S.A., has been estimating fossil fuel carbon dioxide emissions for more than 20 years. These emission estimates are based on fuel statistics, carbon contents, and the fraction of fuel oxidized. This has resulted in an annual time series of emission estimates from the year 1751 to the present. Annual updates add another year to the time series as well as revising data in previous years. Over the years, this basic time series has been supplemented by mapping the emissions at one degree latitude by one degree longitude, describing the time series in terms of stable carbon isotopic (a13C) signature, parsing the time series from annual to monthly time steps, and describing the uncertainty of the global total FFCO2 emissions. Underway now is an uncertainty evaluation of the annual and monthly mapped emissions.

This time series reveals interesting trends when disaggregated by country, fuel type, and source. For example, the proportion of emissions from Kyoto Protocol Annex B and non-Annex B countries has changed since Protocol signing to today. The role of coal in fueling global energy systems has changed from being the primary fuel to becoming secondary to liquid fuels again becoming the primary fuel. The practice of flaring excess gas in oil fields, as a proportion of total energy production, has decreased by more than a factor of four since 1950 and now equates to about 5% of global carbon dioxide emissions from fossil fuel production.

The global fossil fuel carbon dioxide uncertainty analysis resulted in a 2σ range of 1.0 to 13%, which can be greatly simplified to 8.4% (2σ). This uncertainty in the magnitude of fossil fuel carbon dioxide emissions has become an important component to our overall understanding of the global carbon cycle. The uncertainty in the magnitude of mapped fossil fuel carbon dioxide emissions will become a limitation to our understanding of local carbon cycles in the absence of detailed local inventories and observations.

The emission time series has been used by the Global Carbon Project in its annual evaluation of the global carbon budget. The budget is a high level check on the
Potential emissions of CO2 and methane from proven reserves of fossil fuels in the context of the global remaining carbon budget

R. Heede (1); N. Oreskes (2)
(1) Climate Accountability Institute, Snowmass, CO, United States of America; (2) Harvard University, and Climate Accountability Institute, Department of the history of science, Cambridge, MA, and Snowmass, CO, United States of America

Scientists have argued that no more than one-third of proven recoverable fossil fuel reserves can be extracted and consumed by 2050 if we are to avoid exceeding the 2°C temperature target agreed to in Copenhagen (IEA 2012). The remaining carbon budget is ≤275 gigatonnes of carbon (GtC) (assuming a 66% probability of staying below 2°C; IPCC 2014), whereas recoverable fossil fuel reserves contain an estimated 733 GtC (based on BP 2014; IPCC 2014 cites reserves of 1.0–1.9 TtC). Global reserves are based on national assessments without reference to reserve ownership or productive capacity. The studies that do identify corporate owners are limited to investor-owned companies and are focused on major oil-producing countries. We identify the largest seventy investor-owned and state-owned companies that possess the financial and technical capacity (and the ownership or production rights) to exploit and produce the majority of the world’s recoverable reserves of oil, natural gas, and coal. We quantify the potential emissions of CO2 and methane for each entity’s reserves, and compare the emissions to the global remaining carbon budget.

This presentation will report on recent estimates of the potential emissions of CO2 and methane from the proven reserves of the world’s largest producers of oil, natural gas, and coal, focusing on the seventy companies and eight government-run industries that produced 63 percent of the world’s fossil fuels from 1750 to 2012. This report includes detailed reserve profiles (accounting for non-energy uses and flared and vented CO2) is estimated to result in emissions of 440 GtC of carbon dioxide — or 160 percent of the remaining 275 GtC carbon budget. Of the 440 GtC attributed, the 42 investor-owned oil, gas, and coal companies hold reserves with potential emissions of 44 GtC, whereas the 28 state-owned entities possess reserves of 210 GtC — equivalent to 16 percent and 76 percent of the remaining carbon budget, respectively. Government-run industries possess reserves of 185 GtC (16% of the remaining budget).

This analysis shows that (1) the profound risk to the future arises not so much from the proven reserves in the hands of publicly-traded corporations, but from their ongoing exploration for and development of new fossil fuel resources; (2) these global-scale processes may be most vulnerable to investor and consumer pressure, effective action to control climate change must also include the state-owned companies and governments that hold the preponderance of reserves. This work will inform climate scientists, energy and emission scenario modelers, climate negotiators, national climate and energy policy leaders, and investors in fossil fuel companies with practical data on the potential consequences of fossil fuel reserves held by specific companies with the capacity, financial resources, and incentives to extract, refine, and market their own single-epoch carbon storage across large areas of the globe, robust assessments of aboveground carbon dynamics remain lacking. Existing evidence for tropical forests as a carbon sink is based on a limited number of repeated in situ measurements that have been scaled to characterize sequestration dynamics across large regions of the tropics. As an alternative approach, in 2012, we combine wall-to-wall satellite image data, Light Detection and Ranging (LiDAR) measurements and field data to empirically examine aboveground biomass dynamics and methane emissions across lowland and highland tropical forests (A.Baccini et al., 2012), we combine wall-to-wall satellite image data, Light Detection and Ranging (LiDAR) measurements and field data to empirically examine aboveground biomass dynamics and methane emissions across lowland and highland tropical forests.

Global methane budget and natural gas leakage based on long-term 13CH4 measurements and updated isotopic source signatures

S. Schwietzke (1); O. Sherwood, (2); PP. Tans, (1); MS. Englund, (2); G. Etiope, (3); A. Ionescu, (4); JB. Miller, (1); EJ. Dlugokencky, (1)
(1) National Oceanographic and Atmospheric Administration ERL/GMD, Boulder, CO, United States of America; (2) University of Colorado at Boulder, Institute of arctic and alpine research, Boulder, CO, United States of America; (3) Istituto Nazionale di Geofisica e Vulcanologia, Rome, Italy; (4) Babes-Bolyai University, Cluj-Napoca, Romania

Methane (CH4) is a greenhouse gas (GHG) with the second largest global radiative forcing contribution after CO2. Its atmospheric abundance has increased by about 150% since the industrial revolution. Given the critical role of CH4 in global climate change, it is important to better understand its sources and sinks. Improving the estimates of individual source magnitudes – such as fossil fuels, agriculture, and other anthropogenic and natural sources – helps prioritizing CH4 emissions mitigation efforts.
and modeling future climate change. Policy-makers rely strongly on accounting-based national and international emissions inventories to inform mitigation regulatory action. However, recent field studies indicate that emissions inventories may significantly underestimate fossil fuel CH4 leakage (emissions associated with extraction, usage of natural gas, oil, and coal). In this work, atmospheric measurements from the National Oceanographic and Atmospheric Administration (NOAA) Global GHG Reference Network indicate the potential for increased CH4 emissions from fossil fuels and other sources in comparison with inventories and other estimates. Atmospheric measurements include global CH4 lifetime of 13 CH4, which are stable isotopes used in a global box-model to constrain source magnitudes. First, probability distribution functions of the key model parameters are derived including literature isotopic source signatures, isotopic fractionation factors, atmospheric CH4 lifetime, and fossil fuel hydrocarbon gas compositions. Our isotopic source signature distributions are based on the largest literature survey to date, which suggests significant corrections compared to previous studies. Second, a Monte Carlo simulation of the box-model is performed to quantify confidence intervals of individual emissions sources. We found that the majority of increased CH4 levels over the past three decades to microbial sources is consistent with 13CH4. The sum of CH4 emissions from the fossil fuel industry and geological seepage is significantly larger than previous estimates, while the contribution of pre-industrial isotopic ice core records. Third, recently published estimates of global CH4 emissions from oil and coal production are subtracted from global fossil fuel CH4 results to quantify global CH4 leakage from the natural gas industry during extraction, processing, transport, and distribution of the fuel. Natural gas CH4 leakage as a fraction of total production is consistent with estimates over the same period indicating industry efficiency improvements. The results highlight a major gap in our understanding of global CH4 emissions. This motivates increased collaboration efforts between emissions agencies and regulatory agencies to explain and reconcile the differences between atmospheric measurements and emissions inventories.

Arctic Deposition of Black Carbon from Biomass Burning in Northern Eurasia from 2002 to 2012

WM. Hao (1) ; N. Evangelion (2) ; Y. Balkanski (3) ; S. Urbanski (1)

(1) US Forest Service, Missoula Fire Sciences Laboratory, Missoula, MT, United States of America; (2) Norwegian Institute for Air Research, Atmospheric and climate research, Kjeller, Norway; (3) Institut Pierre et Simon Laplace, Laboratoire des sciences du climat et de l’environnement, Gif sur Yvette Cedex, France

Black carbon (BC) in smoke plumes in Northern Eurasia can be transported and deposited on Arctic ice and accelerate melting during certain times of the year. Thus, we examined daily BC emissions from fires in this region at a 500 m x 500 m resolution from 2002 to 2012 and modeled the BC transport and deposition in the Arctic. Black carbon emissions were estimated based on MODIS land cover maps and detected burned areas, the Forest Inventory and Survey of the Russian Federation, and biomass specific BC emission factors. Annual burned areas in Northern Eurasia varied considerably with an average of 260,000 km² for the study period. Grassland dominates the Boreal (80%) area, followed by boreal forest (15%), forest by forest (5%), with about 90% of the area burned occurred in Central and Western Asia and about 17% in Russia. More than 90% of the forest burned area was in Russia. All burned areas from Northern Eurasian fires varied enormously with an average of 0.85 Tg. In contrast to burned area, BC emissions from forest fires accounted for about two-thirds of the emissions, followed by grassland (33%) and forest (25%). More than 50% of the BC that is emitted from forest fires occurred in Russia. Central and Western Asia is the major region for BC emissions from grassland fires (53%). Overall, Russia contributed 83% of the total BC emissions from fires in Northern Eurasia.

The transport and deposition of BC on Arctic ice from all the global sources was estimated using the LMDz-MIP4 ICAN global chemistry–aerosol–climate model at the LSCE. Overall, about 55% of emitted BC was deposited on the Arctic ice. Biomass burning over Northern Eurasia was the dominant source (54%) of the BC deposition in the Arctic. Anthropogenic sources in Northern Eurasia accounted for 24% of BC deposition in the Arctic, while all sources from North America and southern Asia comprised the balance. Secularly, biomass burning contributed 68% of the BC sources in the Arctic in the spring and 81% in the summer, while anthropogenic sources contributed 73% in the winter and 67% in the fall. About 49% of total BC deposition in the Arctic originated from Asia and only 3% was from Europe. Geographically, in Asia, Siberia was the major source (59%) for the BC deposition in the Arctic, followed by Kazakhstan (18%) and Mongolia (8%).

These results are critical to understanding the contribution of black carbon from biomass burning to accelerated melting of Arctic ice under future climate conditions.

Changes in the global methane budget since 2000

P. Bousquet (1); M. Saunois (1); B. Poulter (2); P. Ciais (3); J.P. Canadell (4); EJ. Dlugokencky, (5); A. Peregon (1); M. Global Carbon Project (6)

(1) Université de Versailles St Quentin en Yvelines; Laboratoire des sciences du climat et de l’environnement, Gif sur Yvette, France; (2) Montana State University, Ecosystem dynamics lab, Bozeman, United States of America; (3) LSCE, CEA, CNRS and UVSQ, Gif-sur-Yvette, France; (4) Global Carbon Project, CSIRO marine research, Canberra, Australia; (5) National Oceanographic and Atmospheric Administration, Eslr/gmd, Boulder, CO, United States of America; (6) Global Carbon, Project, Paris, France

Methane is the second anthropogenic greenhouse gas after carbon dioxide. Anthropogenic methane has contributed 20% of the climate forcing by long-lived greenhouse gases since pre-industrial times. It influences the oxidizing capacity of the atmosphere. With a lifetime around 10 years in the atmosphere and a diversity of emission types, methane is an important target for climate change mitigation. Observations of atmospheric methane began in 1978, reached global coverage after 1983, and now include a large variety of in-situ and remote-sensed observations. After the loss of SCIAMACHY (2002–2012), two space missions are currently producing methane
Although sources and sinks of methane are identified, large uncertainties remain in their spatio-temporal quantification. A synthesis of methane emissions and sinks since 2000 using an integrated approach to combine: atmospheric measurements, chemistry-transport models, ecosystem models, emission inventories, and climate-chemistry models. The results are an ensemble of atmospheric inversions (top-down) and process-based models (bottom-up) are presented and compared. Global and regional methane budgets and their changes are presented and discussed for the period 2000–2012. Possible scenarios are presented to explain the increase of atmospheric methane after 2006, after almost a decade of stagnation. Year-to-year changes are also analysed after 2006 in order to identify robust changes as opposed to still uncertain ones.

(6) Global Carbon project / methane is a group of scientists working to improve the global methane budget:


P-1114-03

Fossil fuels ultimate recovery appraisal, clue to climate change modelling

B. Durand (1)

(1) retired from ENS de Géologie, Geology, Arvert, France

According to IPCC report, Climate Change 2013 (the Physical Science Basis), as shown by figure SPM.10 of Summary for Policymakers, temperature of the earth’s surface at the end of the century would depend primarily on the cumulative quantity of CO2 from anthropogenic sources emitted since 1860. Because roughly 80 % of these emissions are produced by fossil fuels combustion, according to this modelling, fossil fuels ultimately recalculate all the main drivers of climate change during this century and the followers.

Since production histories of fossil fuels are already long, it is shown in this paper, as is shown in this paper, to present a good approximation their quantities to be eventually produced. This is done by statistical methods, using mainly the construction of creaming curves of technical reserves discoveries and Hubbert’s production linearization.

These quantities are such that a temperature increase till the end of the century as high as described by RCP 8.5 and above is highly improbable even in a Business As Usual scenario. And staying below a 2 °C temperature increase from 1860 on remains obviously possible, provided that use of coal is now strongly restricted. This is the responsibility of the main coal consumers.

(1) of them, China, the USA, India, Japan, South Africa, Russia, and Australia. The main coal users, and India, Poland and Indonesia consume nearly 90 % of the world’s total coal production. As a result, these 10 countries also produce for the moment most of the world CO2 emissions. Therefore the way the IPCC modelling, the main drivers of climate change. They should definitely cooperate to undertake immediate and strong action.

Exploitations of bituminous shales, methane hydrates, or of coal by underground gasification are not considered here. They are for the moment highly hypothetical at a large scale. Nevertheless they should not be encouraged.

P-1114-04

Extending the relationship between global warming and cumulative carbon emissions to multi-millennial timescales

T. Fröhlicher (1)

(1) ETH Zurich, Zurich, Switzerland

Climate model simulations and theoretical arguments indicate an approximately linear relationship between cumulative carbon emissions and projected global mean temperature over the 21st century and beyond in a wide set of future carbon emissions scenarios. This Transient Climate Response to cumulative carbon Emissions (TCRE) is estimated to be in the range of 0.8–2.5°C/100 Gt carbon. TCRE is defined for peak temperature and is therefore independent of the rate of carbon emissions. Any global temperature target therefore implies a limited carbon emissions budget. TCRE is a simple and useful policy framework and may play an important role in the post-Kyoto political negotiations for a new global agreement on future carbon emissions.

A recent modeling study (Fröhlicher et al. 2014) using carbon pulse experiments of a comprehensive global atmosphere–ocean general circulation model (AOGCM) finds that global mean temperature may continue to increase on multi-centennial timescales even after stopping carbon emissions. In other words, there may be a significant amount of warming expected from past carbon emissions. These results imply that the linear relationship between global warming and cumulative carbon emissions breaks down when the carbon emissions are tapering off. This is in contrast to a large body of studies suggesting that global mean surface temperature stays roughly constant for a couple of centuries at the value attained when carbon emissions are stopped. These earlier studies, however, use climate models of intermediate complexity, which simplify the complexities of many processes such as cloud feedbacks.

These results call for an extension of the TCRe concept. Here I use climate models of different complexities to show that the TCRe concept can be characterized by two different time phases and that the TCRe concept is only valid during the first phase, when emissions are steadily increasing. For longer time-scales, when emissions are tapering off, two new metrics will be introduced that better characterize the time-dependent temperature response to cumulative carbon emissions, namely the Peak Climate Response to cumulative carbon Emissions (PCRE) and the Equilibrium (multi-millennial) Climate Response to cumulative carbon Emissions (ECRE). I will explain why the PCRE is generally larger than the TCRE in the fully coupled AOGCMs and why the models of intermediate complexity as a class don’t simulate an increase in multi-centennial mean temperature after carbon emissions stoppage. The implications of these results for allowable carbon emissions required to remain below a specific global warming target will be discussed.


P-1114-05

Hydrological and biogeochemical constraints on terrestrial carbon cycle projections

S. Mystakidis (1) ; N. Gruber (2) ; LE. Davin (1) ; S. Seneviratne (1)

(1) ETH Zurich, Institute for atmospheric and climate science, Zurich, Switzerland; (2) ETH Zurich, Institute of biogeochemistry and pollutant dynamics, Zurich, Switzerland

Terrestrial ecosystems are playing a crucial role in the climate system by absorbing about one third of the total anthropogenic emissions of CO2, thus providing a valuable ecosystem service to mankind. How this ecosystem service will evolve in the coming decades is still a subject of debate. This evolution depends on the response of biogeochemical cycles and ecosystems to a changing climate with more frequent and severe extreme events in some regions as well as to increased CO2 concentrations. Earth System Models which are explicitly represent the
ecosystem behavior such as the exchange of carbon and water with the land and ocean are used to study the future evolution of the land and ocean carbon cycle sinks. However, the estimates of these carbon fluxes are clearly subject to significant uncertainties. Observationally-based carbon cycle models simulating these fluxes should therefore facilitate reduce uncertainties in future terrestrial carbon cycle projections for AR5 (CMIP5).

Gross Primary Production (GPP) is the total amount of carbon that is taken up by plants during photosynthesis and it is one of the main components of the land carbon cycle and driver of the carbon uptake by land. We show that some models simulating high present-day GPP and Evapotranspiration (ET) tend to simulate higher increase in future GPP. Using these emergent relationships combined with present-day estimates of ET and GPP we constrain future changes in GPP. We find that the inter-model spread in future GPP is reduced by at least 50% while increase in future GPP in northern latitudes is higher than previously thought. Our results for future changes in Water Use Efficiency (WUE), a highly significant determinant of primary production of terrestrial ecosystems, show similar behavior. Applying the observational constraints on the future land sink (NBP) reveals higher than previously thought decrease in the land sink. The inter-model spread in the land sink is reduced by more than 30% and in most of the constrained ensembles the terrestrial biosphere is even predicted to be a carbon source by the end of the century. Our findings therefore have several implications on the future productivity of ecosystems and the atmospheric CO2 concentrations.

P-1114-06 Air Pollution Emissions and Potential for Co-Benefits in Megacities of South Asia
BR. Gurjar (1)
(1) Indian Institute of Technology Roorkee, Civil Engineering Department, Roorkee, India

The South Asian region is highly and densely populated and includes numerous megacities (each with population more than 10 million) and hundreds of large and medium size cities. Megacities in South Asia are namely - Delhi, Mumbai and Kolkata (India), Dhaka (Bangladesh) and Karachi (Pakistan). Constantly increasing energy-intensive urban activities in burgeoning cities areas are responsible for a large share in the unacceptably high emissions of those air pollutants, which are responsible for poor air quality, adverse health effects and also climate change. High levels of Air pollution in South Asia came into highlight by the South Asian haze called Atmospheric Brown Cloud (ABC). The annual premature deaths due to ABC were estimated equal to 100,000s in the South Asian region. Whereas, recent estimates of the burden in India show approximately 1.04 million premature deaths and 31.4 million disability-adjusted life years (DALYS) to be attributable to household air pollution (HAP) resulting from solid cooking fuels. Numerous policy measures and technological interventions are being tried in India and other countries to curb the air pollution. However, there is a growing interest in adopting those measures which can reduce air pollution emissions resulting in not only air quality improvement and health benefits but also in climate change related co-benefits.

This presentation would provide an analysis of the urban pollution emissions and potential for health and climate change related co-benefits in South Asian megacities. Most of the South Asian countries are in the stage of developing economy among them, giving the increasing trend of energy use and emissions in South Asian cities, present study is a step to make governments and people aware of severe air pollution problem. The analysis presented in this study is expected to help initiate appropriate policy measures and suitable action plans to limit air pollution emissions and urban development benefits approach co-benefits of air pollution problem and promote the sustainable development - especially in South Asia.

P-1114-07 Cumulative carbon emissions modulated by policy options for limiting warming to below 1.5 and 2°C

J. Rogelj (1) ; M. Schaeffer, (2) ; M. Meinshausen, (3)
(1) IIASA, Laxenburg, Austria; (2) Climate Analytics, Berlin, Germany; (3) University of Melbourne, Australian-german college of climate & energy transitions, school of earth sciences, Melbourne, Australia

Cumulative emissions of carbon dioxide, or so-called carbon budgets, have recently received increasing attention in the climate policy arena. Not only are they part of the headline statements of the most recent assessment of the Intergovernmental Panel on Climate Change (IPCC), they have also been proposed as guidance for long-term emission reduction goals within the international climate negotiations under the United Nations Framework Convention on Climate Change (UNFCC). For example, directly following from the concept of a carbon budget is that as soon as 2055 to 2070, global net emissions of CO2 will have to be reduced to zero in order to stay below 2°C warming with a likely chance.

A thorough understanding of the interplay between policy choices and the amount of carbon emissions compatible with specific temperature limits gains therefore in importance, in particular because the amount of future carbon emissions compatible with limiting warming to below 1.5 or 2°C thresholds is vanishing quickly with time. Mitigation costs are related to the size of the carbon budget and can increase significantly with a delay of strong decarbonisation, as weaker reduction ambition early on could mean the necessity of much stronger reduction rates later.

We provide key insights that link the theoretical concept of carbon budgets to a real-world context, by quantifying policy-relevant emission–scenario aspects that increase or decrease cumulative carbon emissions compatible with limiting warming to below specific temperature limits, like 1.5 or 2°C relative to pre-industrial. To achieve this, we explore dimensions not previously assessed by the IPCC.

First, we show that the choice of methodology to derive compatible carbon emissions from integrated multi–gas emission scenarios plays a non–negligible role. Both the influence of non–CO2 forcing variations and the timescales of the Earth system response lead to lower compatible carbon emissions when derived from low instead of high emission scenarios. Second, as non–CO2 forcing has the potential to modulate carbon budgets, we assess the potential influence of the mitigation of so-called short-lived climate pollutants (SLCP, like methane, soot, or hydrofluorocarbons) on the size of compatible carbon budgets. We show how, due to technological linkages between the sources of CO2 and some SLCPs, the potential impacts can vary strongly across species. Third, we explore how socio–economic developments and technological policy choices can influence the size and cost of a carbon budget for mitigation of temperature-related climate change. In particular, we show how and how much the potential to modulate carbon budgets, we assess the potential influence of the mitigation of so-called short-lived climate pollutants (SLCP, like methane, soot, or hydrofluorocarbons) on the size of compatible carbon budgets. We show how, due to technological linkages between the sources of CO2 and some SLCPs, the potential impacts can vary strongly across species.
the implemented policies. Therefore, concerted efforts in emission inventories are needed to improve the quality of the emission estimates and to be able to reproduce air quality conditions in models. In this context, the CMIP project was established to provide a basic support for future research. However, it has requested further improvements on the emissions data by using observations, as well as on the emissions spatial and temporal resolution. Among others, a high priority is given to the development of anthropogenic hydrocarbon and particle speciation.

Non-Methane Volatile Organic Compounds (NMVOCs), emitted from various sources, are of particular interest since they affect urban air quality and regional climate change by contributing to the formation of tropospheric ozone, PAN and Secondary Organic Aerosols. According to Shindell et al. (2012), NMVOC emissions could help slow the near-term rate of climate change because of their influence on short-lived climate forcers (e.g., ozone, methane, aerosols). Thus, reducing NMVOC emissions provides regional to global benefits to air quality and climate (Fry et al. 2014). Some studies have shown that the NMVOC composition depends on the regional characteristics, even among the northern mid-latitude megacities (Beirut, with a focus on the organic carbon, and rCps inventories, the total anthropogenic emissions within the transeMeD initiative. According to the aCCMip latitude cities) and in the eastern Mediterranean Basin within the TRANSEMED initiative. According to the ACCMIP and RCPS inventories, the total anthropogenic emissions of NMVOCs in the MEA region were constantly increasing reaching ~15 Tg in 2010 whereas in USA and Europe, the NMVOCs emissions were decreasing reaching ~10 Tg in 2010 (ECCAD database). A very detailed and unique emission inventory database was developed for the Middle East, Beirut, with a focus on the organic carbon, and in Istanbul. Since, the current NMVOC speciation applied in models needs updating, source profiles were determined by the implemented measurements closer to the main potential emitters (Salameh et al. 2014).

References:

P-1114-09

Black Carbon emission and its climate implication in Pakistan

I. Shahid (1)
(1) Institute of Space Technology, Islamabad, 1–Islamabad highway near Rawat Toll Plaza; Islamabad, Pakistan

Black carbon (BC) is a product of incomplete combustion (burning that gives off smoke). It is the solid, mostly pure carbon component of soot that is capable of absorbing light at all wavelengths. Black carbon emissions in South Asia are primarily derived from four sectors: residential, industrial, transportation, and biomass burning (field burning, cook stove burning). The region represents the largest single source of black carbon emissions in South Asia. The transportation and industrial sectors are also significant contributors (US EPA 2012). Black carbon deposition on snow and ice surface and decreases reflectivity, thereby increasing absorption and accelerating melting. Kopacz et al., (2011) reported the role of BC in Himalaya glacier melting and change of radiative forcing in the region due to BC.

Emission inventories and analyses of aerosol samples indicate that more than half of the black carbon emitted in South Asia comes from the burning of biofuels, especially in traditional cook stoves. Shahid et al., (2015) reported that burning of different wood species for cooking emits 22% BC of the total amount of biomass burned. Other large sources include the burning of crop residues (waste burning, and forest fires. Many sources of black carbon also co-emit other substances that are less light-absorbing, or that scatter light, including brown carbon, carbon also co-emit other substances that are less light-absorbing, or that scatter light, including brown carbon, and sulfate. Emissions from diesel trucks have a higher percentage of pure black carbon than emissions from open fires. The overall effect of BC in any region will therefore be a result of local / regional / global emission, climate and geography. For example, in the Himalayas BC can amplify the effects of enhanced greenhouse warming while, in addition, causing surface dimming which can reduce crop productivity. There have been efforts to build emission inventories in Pakistan, however, this has been sporadic and specific. Three local efforts in 1990 (Burns et al., 1994), 1994 and the latest in 2009 have all focused on greenhouse gases (GHG), and BC carbon was ignored. In global and regional emission inventories scarce information is available for Pakistan. In this study BC emissions have been estimated from different sectors using Atmospheric Brown Cloud emission inventory manual with emphasis of biomass burning for cooking and field burning (crop Residue). Unfortunately no sector specific emission factors are available. Thus we used emission factors that have been already published and closely related to Pakistan environment. During the year 2013–14, 16.923 x 106 Hectare area was cultivated for crop production, and 116 x 106 tonnes of crops were produced which in turn produced 40 x 106 tonnes of dry mass that was burnt in field. Thus single source of crop residue burning emits about 24 mega tonnes of BC along with other pollutants. Based of this data emission maps will be generated for gridded emissions over Pakistan.

These are the preliminary results, work is going on and hopefully will be able to finish till June.

P-1114-10

National and regional contributions to global climate change

RB. Skeie (1); JS. Fuglestvedt (1); M. Allen (1); T. Berntsen (1); GP. Peters (1)
(1) CICERO, Oslo, Norway

According to the "Brazilian Proposal" from 1997, the industrialized countries should reduce emissions proportional to their contribution to temperature increase. The emissions of Greenhouse Gases (GHG) and Short-Lived Climate Forcers (SLCFs) have been under discussion since the last decade with large regional differences, suggesting that previous estimates are outdated. In this work we update earlier estimates of the contributions to global mean temperature changes from the year 1750 to the present. We perform deeper analysis of various scientific and policy related choices. Which time period should be accounted for when calculating the countries’ contributions? We show the importance of the start year, end year, and the summation year on countries’ contributions. Another choice is which forcing components that should be included in the analysis. First we consider only CO2 from fossil fuels and then we extend the analysis to other fossil fuel gases and C02 from land use change are included, and then non-Kyoto gases together with SLCFs. Time series of emissions of GHGs, aerosols and its precursors for countries/regions are constructed and a simple climate model is used to calculate the temperature response. Another policy choice is for which stage in the emission chain the contributions should be calculated (extraction, production (territorial), consumption). Finally we will discuss how the historical responsibilities of countries/regions can be seen in relation to attribution to extreme events based on work in the EU-project EUCLEIA.
Biogenic CH4 and N2O emissions overwelm land CO2 sink: implications for climate change mitigation

H. Tian (1); C. Lu, (1); P. Clais (2); A. Michalak, (3); J.P. Canadell (4); E. Saikawa, (5); D. Huntzinger, (6); K. Gurney (7); S. Stitich, (8); B. Zhang, (1); J. Yang, (1); P. Bousquet (9); M. Brunskill (10); D. Chen, (11); EJ. Dix, (10); P. Friedlingstein (8); J. Mellilo, (12); S. Pan, (1); B. Poulter (13); R. Prinn, (14)

(1) Auburn University, School of Forestry and Wildlife Sciences, Auburn, AL, United States of America; (2) LSCE, CEA, CNRS, ENS-Lyon, France; (3) Carnegie Institution for Science, Department of global ecology, Stanford, United States of America; (4) Global Carbon Project, CSIRO marine and atmospheric research, Canberra, Australia; (5) Emory University, Department of environmental sciences, Atlanta, United States of America; (6) Northern Arizona University, School of earth sciences and environmental sustainability, Flagstaff, United States of America; (7) Arizona State University, Tempe, United States of America; (8) University of Exeter, Exeter, United Kingdom; (9) Université de Versailles St Quentin en Yvelines, Laboratoire des sciences du climat et de l'Environnement, Gif sur Yvette, France; (10) National Oceanographic and Atmospheric Administration, ESRL/gmd, Boulder, CO, United States of America; (11) Oak Ridge National Laboratory, Environmental sciences division, Oak Ridge, United States of America; (12) Marine Biological Laboratory, Woods Hole, United States of America; (13) Montana State University, Ecosystem dynamics lab, Bozeman, United States of America; (14) Massachusetts Institute of Technology, Center for global change science, Cambridge, United States of America

The stabilization of greenhouse gas (GHG) concentrations in the atmosphere requires reducing net anthropogenic GHG emissions and increasing the capacity of carbon sinks in the biosphere. Although global terrestrial CO2 uptake partially mitigates global warming, its contribution may be offset or even overturned by the increasing biogenic emissions of methane (CH4) and nitrous oxide (N2O). Of particular importance to climate change mitigation policies is the ability to evaluate the net balance of these three GHGs in the atmosphere. Here we synthesized multiple estimates of CO2, CH4 and N2O from various studies to investigate the net biogenic GHG budget (NBGB) on global and regional scales. Based on 22 bottom-up studies using terrestrial biosphere models, empirical and inventory-based approaches and 7 top-down studies using atmospheric inverse models, we conclude that global terrestrial ecosystems had a net positive NBGB, indicating that greenhouse gas release to the atmosphere. After subtracting pre-industrial GHG emissions from land ecosystems, we found the global land uptake of anthropogenic CO2 (~7.7 to ~9.2 Pg CO2 eq/yr) was offset by 12.3% to 18.4% due to anthropogenically-caused emissions of CH4 and N2O. Among them, agricultural CH4 and N2O emissions (7.0 to 8.0 Pg CO2 eq/yr) play the most important role, offsetting 85% - 103% of the global land sink. It is clear that biogenic CH4 and N2O emissions had overwhelmed the global land CO2 sink, contributing to a net climate warming effect of all the GHG exchanged to or from the land biosphere. Our results indicate that effective agricultural management strategies are very much needed to alleviate biogenic GHG emissions, while sustaining food and bioenergy production.

Emissions metrics and evaluating methane-emitting natural gas as a bridge fuel

J. Trancik (3); M. Edwards (1); M. Klemun (2); M. Roy, (3)

(1) MIT, Cambridge, MA, United States of America; (2) Massachusetts Institute of Technology, Engineering Systems Division, Cambridge, United States of America; (3) MIT, Cambridge, United States of America

Climate change mitigation is a multi-gas problem. Mitigation policies that focus on CO2 reductions alone may result in increased emissions of other gases such as CH4, leading to overshoots of climate policy goals. For example, policies aimed at reducing CO2 emissions might encourage a transition from coal to natural gas electricity, enabled by increased production of unconventional gas, but could also lead to higher CH4 emissions due to leakage in the natural gas supply chain. Therefore, it is important to consider multiple gases in making emissions reductions and commitment to technology options to meet these goals. Here we present an approach to evaluating policies and technologies based on their multi-gas emissions.

Evaluating technology options on a common scale, or setting a national target for overall GHG emissions reductions, requires some means of comparing different gases on a common scale. This comparison is challenging because of the dissimilar removal dynamics of different GHGs. Emissions equivalency metrics are a commonly used approach, and the global warming potential (GWP) is the most prominent one. The GWPs of non-CO2 GHG emissions to a CO2-equivalent value based on a time-integrated radiative forcing comparison over a fixed horizon of 100 years, leading to a conversion factor that is constant over time. This approach can lead to significant overshoots of climate policy goals, such as radiative forcing stabilization targets, because it doesn’t take into account how close in time emissions occur relative to an intended stabilization year.

Here we present an alternative set of dynamic emissions equivalency metrics that evaluate emissions impacts relative to an intended radiative forcing stabilization level [1]. Our approach results in a lower impact value on shorter-lived greenhouse gases, like CH4, early on, but increases this value as emissions approach an intended stabilization time. The metrics are relatively independent of the future emissions and energy consumption scenario to be followed, and therefore can be used to evaluate policy and technology options despite the inherent uncertainty about the future. Applying the metrics to set emissions reduction targets and evaluate technologies results in substantially lower overshoots of climate policy targets than the GWP. Furthermore the metrics points to methane mitigation timelines that can allow for greater energy consumption while meeting climate policy goals [2].

How might dynamic metrics be used in setting policy targets? We will discuss a specific example by examining the US Environmental Protection Agency’s Clean Power Plan target of 30% reduction in power sector CO2 emissions by the year 2030 (from 2005 levels). This policy incentivizes a shift to natural-gas based electricity generation, and could result in significant increases in power sector CH4 emissions. Applying the time-sensitive metrics mentioned above, overall GHG reductions (counting both CO2 and CH4) may only reach 10–20% by 2030, instead of the targeted 30%, without additional methane regulation. However, as shown by applying the proposed dynamic metrics, reduction rates of 11–13% per year would allow the 30% by 2030 GHG reduction target to be met [3]. As demonstrated by this US example, capturing the full climate benefit of coal-to-gas technology transitions requires substantial CH4 mitigation to complement the CO2-focused climate policy framework. The alignment of CO2 abatement and CH4 leakage reduction goals is an important problem that needs to be addressed as nations globally prepare policy proposals for the 2015 International Climate Change Conference in Paris (COP21). The method proposed here provides an approach to setting coupled CO2 and CH4 reduction targets, and evaluating mitigation technologies.

A global estimate of carbon stored in the world’s mountain grasslands and shrublands, and the implications for climate policy

A. Ward (1); P. Dargusch (2); S. Thomas (2); Y. Liu (2); E. Fulton (3)

(1) University of Queensland, Brisbane, Australia; (2) University of Queensland, Brisbane, Queensland, Australia; (3) Commonwealth Scientific and Industrial Research Organisation, Hobart, Australia
Carbon market and climate finance schemes (e.g. the CDM, REDD+ and the Green Climate Fund) are being investigated for their ability to achieve enhanced sustainability outcomes in terrestrial forests, lowland grasslands and marine ecosystems, all which store large amounts of carbon and are also affected by climate change. However, it has largely overlooked the conservation of existing C stored in mountain grasslands and shrublands. These ecosystems provide critical ecological goods and services to humanity yet are increasingly at risk from anthropogenic stressors including agricultural intensification, mining and climate change. The absence of a global estimate for these C stocks is likely to be one reason for their exclusion from climate change policy discussions, both on a political and scientific basis. This represents a missed opportunity in two respects: firstly, by conserving and restoring existing C stocks the impacts of climate change can be lessened; and secondly, carbon finance and climate finance might provide financial support to address the aforementioned stressors. Here we use spatial analysis and estimate there to be between 60.5 Pg C and 82.8 Pg C of C contained within biomass and soils of the world’s mountain grasslands and shrublands. To put this in perspective, globally tropical savannas and grasslands, temperate forests and shrublands, to put this in perspective, globally tropical savannas and grasslands, temperate forests and shrublands, to put this in perspective, globally tropical savannas and grasslands, temperate forests and shrublands, to put this in perspective, globally tropical savannas and grasslands, temperate forests and shrublands. to put this in perspective, globally tropical savannas and grasslands, temperate forests and shrublands.

P-1114-14
Global and China’s admissible emissions pathways under various warming targets
Y. Zhu (1); Z. Wang (1)
(1) Institute of Policy and Management, Chinese Academy of Sciences, Beijing, China

Using the adaptive control model with climate system, this paper projected and compared the global admissible emission pathways under various warming targets, namely, warming 2°C above pre-industrial level, and the average level of 1850–1900, 1861–1880, 1961–1990, 1980–1999 and 1986–2005 that mentioned in IPCC-AR5 WGI report. Our study shows that the admissible emission is required to reduce by 20%, 35%, 50% and 62% until 2020, 2030, 2050 and 2100 respectively so as to limit the global warming within 2°C above the preindustrial level. This interests in the Copenhagen discourse of financial support to the sustainable development. We conclude by briefly discussing how climate change policy discussions, both on a political and scientific basis. This represents a missed opportunity in two respects: firstly, by conserving and restoring existing C stocks the impacts of climate change can be lessened; and secondly, carbon finance and climate finance might provide financial support to address the aforementioned stressors. Here we use spatial analysis and estimate there to be between 60.5 Pg C and 82.8 Pg C of C contained within biomass and soils of the world’s mountain grasslands and shrublands. To put this in perspective, globally tropical savannas and grasslands, temperate forests and shrublands.

K-1115-01
The GOSAT contribution to understanding global concentration distribution and regional fluxes of carbon dioxide and methane over its five-year operation period
T. Yokota, (1); S. Maksyutov (1); N. Kikuchi (1); Y. Yoshida (1); A. Bril (1); M. Inoue, (1); L. Morino, (1); O. Uchino, (1); H. Takagi (1); HS. Kim (1); R. Janardanan, (1); DA. Belikov, (2); M. Ishitazawa (1); M. Saito (1); F. Kawazoe (1); M. Ajiro (1)
(1) National Institute for Environmental Studies, Tsukuba, Japan; (2) National Institute for Polar Research, Tokyo, Japan

The Greenhouse gases Observing SATellite (GOSAT) has been operating for more than five-and-a-half years since January 2014. Over this period, the NIES GOSAT Project provided researchers and the general public with the retrieved column-averaged concentrations of carbon dioxide (XCO2) and methane (XCH4) (Greenhouse gas (GHG) SWIR Level 2 data products), which helped advance the global distributions of the two global warming gases and their variability with time and space. Further, with those concentration data that filled gaps in the existing surface monitoring networks, the monthly estimates of regional sources and sinks of CO2 and CH4 (Level 4 data products) were produced with smaller uncertainties. Although there are some issues still left that need to be handled, such as regional and time-dependent biases and low retrieval success rates over the tropics, the GOSAT Project has contributed significantly to advancing the global carbon cycle studies through providing useful space-based GHG data. The Orbiting Carbon Observatory 2 (OCO-2) was launched successfully in July 2014, and now and finally, there are two CO2 monitoring platforms in space, as originally planned ten years ago. GOSAT is expected to operate and continue its observation for the next several years even after its five-year nominal operation period ended in early 2014. Evaluating and inter-comparing data from the two platforms will yield valuable findings that can further advance the space-based GHG program. It will present the overview of the latest GOSAT data products and some of important research outcomes brought by the GOSAT Research Analysis Center (RAC) researchers, and show our views on the future of space-based carbon cycle study by worldwide research collaboration.

O-1115-01
The Integrated Carbon Observation System (ICOS RI) – a European Research Infrastructure on greenhouse gases and the global carbon cycle
WL. Kutsch (1); A. Vermeulen, (2); T. Johannessen, (3); I. Levin, (4); D. Papale, (5); L. Rivier, (6); A. Watson, (7)
Greenhouse gases contribute to radiative forcing and therefore their concentrations in the atmosphere influence the climate of the Earth. The mission of ICOS RI is enabling research for understanding present state and predicting future behavior of the global carbon cycle and greenhouse gas concentrations. ICOS RI uses the observations from the network to provide long-term observations through a distributed infrastructure with station networks designed to monitor GHG concentrations in the lower atmosphere and ocean as well as GHG exchange between ecosystems or oceans and the atmosphere. By knowing the dynamics of GHG in the atmosphere and their fluxes, ICOS RI will provide independent data to improve and verify GHG emission inventories for international conventions.

This fusion of streams of (big) data from observational in-situ measurements and model simulation is the next step in developing integrated knowledge on global carbon and greenhouse gas budgets. By using the complex model–data fusion systems currently under development, the observations will enable to verify greenhouse gas fluxes on regional and national levels at unprecedented resolution in time and space.

**O-1115-02**

Potential of in-service aircraft based greenhouse gas observations within ICOS for constraining regional carbon budgets

S. Verma (1); J. Marshall (1); C. Roedenbeck (1); C. Gerbig (1)

(1) Max Planck Institute for Biogeochemistry, Biogeochemical Systems, Jena, Germany

Spatial and temporal variations of atmospheric greenhouse gas concentrations contain information about their sources and sinks as well as the exchange processes between the atmosphere and the surface of the Earth. However, the potential use of these observations in inverse models for accurate estimation of eddy fluxes is hindered by the fact that they are both insufficient and unevenly distributed. The use of passenger aircraft for obtaining information about atmospheric composition and physical and chemical processes is a relatively new concept. Within the recently established Integrated Carbon Observation Systems (ICOS) – the service Aircraft for a Global Observing System (IAGOS) – highly accurate and precise in-situ observations of greenhouse gases are visible in the near future. Detailed and continuous measurements are made during long distance flights by hi-tech instruments deployed on board, thus providing a view of the horizontal and vertical distribution of the measured trace gases on a global scale and over long periods of time. The project ICAS (IAGOS for CMES Atmospheric Service) serves as a vital link between the data collected on board civil aircraft through IAGOS and the diurnally atmospheric monitoring service (previously known as CMES) that utilizes these measurements for applications in the field of modeling, weather forecasting and air quality forecasting.

This study is focussed on assessing the impact of measurements from IAGOS on the constraint on the regional carbon budget and quantifying the reduction in uncertainty in the inversion source–sink estimates of CO2 and CH4, brought about by the use of this newly developed data stream. Anticipating the deployment of five GHG observing systems within IAGOS, the flight tracks from five in-service aircraft (Measurement of Ozone and water vapour by Airbus in–service airCraft), a predecessor project of IAGOS, are used in an inversion system to assess the constraint on the carbon budget and quantify the potential for reduction in posterior flux uncertainties. These measurement locations and times are used to evaluate the impact of data from aircraft on the reduction of flux uncertainties compared to that based on the statistical inversion of footprint information only. To identify areas where the addition of these measurements would be of greatest impact. We use the Jena Inversion System that employs the Global Atmospheric Tracer Model TM3 for atmospheric transport, focussing on the period 1996–2004. The vertical aircraft profiles are input into the inversion as two partial–column averages instead of point measurements, the lower partial column completely containing (and exceeding) the boundary layer. This is a novel approach, the advantage being that the error due to imperfect model representation of the boundary layer height and vertical transport is not resolved, but the surface can be diminished, which results in the reduction of the overall model–data mismatch error. The experimental design is such that in each simulation the existing measurement network is augmented by pseudo-observations from up to five simulated IAGOS aircraft. Uncertainty reduction from each of these simulations is compared to the uncertainty reduction from simulations employing only pseudo-observations from the existing data network. We find that for both CO2 and CH4, the additional constraint on the carbon budget brought about by the use of IAGOS measurements is highest for the tropical regions, the magnitude of the change in uncertainty reduction being about 20 percent.

**O-1115-03**

Cost-effective guidelines for measurement of agricultural greenhouse gas emissions and removals

M. Richards (1); T. Rosenstock (2); K. Butterbach-Bahl, (3); M. Rufino (4); E. Wollenberg, (5)

(1) CGIAR Research Program on Climate Change, Agriculture and food Security, Low Emissivity, University of East Anglia, Norwich, United Kingdom; (2) Integrated Carbon Observation System, Carbon Portal, Lund, Sweden; (3) University of Bergen, Bergen, Norway; (4) Universität Heidelberg, Institut fuer umweltphysik, Heidelberg, Germany; (5) University of Tuscia, Viterbo, Italy; (6) LSE, Gif sur Yvette, France; (7) University of East Anglia, Exeter, United Kingdom

In the lead up to the upcoming UN Climate Conference COP21, a methodology and guidelines for cost-effective greenhouse gas (GHG) measurement and inventories for agriculture, forestry and other land use (AFOLU) has been developed. As these guidelines are primarily targeted towards developing countries, they represent an important step in achieving the 2030 Agenda for Sustainable Development, particularly the Sustainable Development Goal (SDG) 13 on climate action. However, their implementation is currently hindered by a lack of guidelines and a shortage of measurement capacity in developing countries. The challenge is to develop guidelines that are applicable for developing countries while maintaining quality and comparability with measurements from developed countries. Here we present the results of a study on measurement methods and their applications in tropical countries.

The guideline development has been based on a literature review and the development of a web-based tool for inventory development. The tool allows users to identify appropriate measurement methods to inventory GHG flows and emissions from various sources in developing countries, based on a large number of references from the literature. The tool is designed to help users to identify appropriate measurement methods for their specific situation, taking into account cost, data availability and accuracy. The tool also includes a database of measurement proposals from around the world that can be used as a starting point for inventory development.

The guidelines also provide guidance on how to calculate and report national and sub-national GHG inventories, and on how to monitor and verify the accuracy of the measurements. They also include recommendations on how to use the guidelines in developing countries, taking into account the specific challenges of these countries. The guidelines are intended to be used by developers, designers and implementers of monitoring and verification systems, and to be used to develop GHG measurement and inventory methods for developing countries. They are also intended to be used by governments, international organizations and others to promote the use of the guidelines in developing countries.

The guidelines also include a number of case studies from around the world that illustrate how the guidelines can be applied in practice. These case studies include examples from developing countries such as India, Indonesia and Brazil. They also include examples from developed countries such as the United States and the United Kingdom. The guidelines also include a number of recommendations for future work, including the development of additional guidelines for other sectors and the development of guidelines for monitoring and verification of GHG emissions from other sources, such as waste and energy.
Reconstruction of super resolution oceanic pCO2 from remotely sensed data and multiresolution analysis: an application in the South Eastern Atlantic

V. Garrín (1); I. Hernandez-Carrasco (1); J. Sudre (1); H. Yahia (2); C. Garbe (3); A. Paulmier (4); B. Dewitte (4); S. Illig (4)

(1) CNRS, LEGOS, Toulouse Cedex 9, France; (2) INRIA, Geostat, Bordeaux, France; (3) University of Heidelberg, Interdisciplinary center for scientific computing, Heidelberg, Germany; (4) IRD, Legos, Toulouse Cedex 9, France

The knowledge of greenhouse gases (GHGs) fluxes at the air-sea interface at high resolution is crucial to accurately quantify the role of the ocean in the absorption and emission of GHGs. We present here a novel method to reconstruct maps of surface ocean partial pressure of CO2, pCO2, and air-sea CO2 fluxes at super resolution (4 km) using Sea Surface Temperature (SST) and Ocean Colour (OC) data at this resolution, and CarbonTracker CO2 flux data at low resolution (110 km). Inference of near optimal cross-scale inference of GHGs fluxes is performed using novel nonlinear signal processing methodologies that prove efficient in the context of oceanography. The theoretical background comes from the so-called singular multifractal formalism which unlocks the geometrical determination of cascading properties of physical intensive variables. As a consequence, a multiresolution analysis performed on the signal of the so-called scalar GHG-exponents allows that correct and near optimal cross-scale inference of GHGs fluxes, as the inference suits the geometric realization of the cascade. We apply such a methodology to the study offshore of the Benguela upwelling system. The inferred representation of oceanic partial pressure of CO2 improves and enhances the description provided by CarbonTracker, capturing the small scale variability. The methodology is validated using in-situ measurements by means of statistical errors. Mean absolute and relative errors in the inferred values of pCO2 with respect to in-situ measurements are smaller than for CarbonTracker.

Top down estimates of the European emissions of hydrofluorocarbons and comparison with bottom up inventories

M. Michela (1); F. Graziosi, (1); J. Arduini, (1); F. Furlani, (1); P. Bonasoni, (2)

(1) University of Urbino, Basic Sciences and Foundations, Urbino, Italy; (2) National Research Council, Institute for the study of the atmosphere and climate, Bologna, Italy

Hydrofluorocarbons are strong greenhouse gases included in the United Nations Framework Convention on Climate Change (UNFCCC) Kyoto Protocol.

Under the Protocol, Parties are required to submit to UNFCCC their annual emission inventories. Such emissions are normally assessed by “bottom up” methods aggregating various local statistics. However, emissions measured by their accumulation in the atmosphere, can significantly disagree with reported bottom-up emissions.

Top-down emission estimates based on in situ long-term high frequency observations combined with inverse modeling have proved to be a powerful and important tool for the quantification of emissions and the verification of bottom-up inventories for many trace gases. Here we present regional (European) emission estimates of nine hydrofluorocarbons characterised by extremely high Global Warming Potentials (GWP).

Emissions estimates are obtained through a combination of observations and models. For this study we used high frequency, long term observations conducted via gas chromatography-mass spectrometry in four WMO-GAW Global stations in Europe that are part of the AGAGE (Advanced Global Atmospheric Gases Experiment) network. The obtained data undergo a rigorous quality control, following the procedures adopted within AGAGE. FLEXPART 20–d backward trajectories and a Bayesian inversion method are then used in order to derive annual emissions from the European Geographic Domain, divided into eight macro-regions, starting from 2001 onward.

Then, we compared our estimates with the bottom-up inventories submitted by the single country to the UNFCCC. Such comparison revealed not negligible discrepancies between the inversion results and the inventories, thus showing the effectiveness of this approach as a verification tool for declared emissions.

The estimates provided by this analysis are relevant not only for constraining the atmospheric budget of these gases on a regional scale, but also to improve the accuracy of their emissions quantification on a global scale.

Observational Determination of Surface Radiative Forcing by CO2 and CH4

W. Collins (1); D. Feldman (2); M. Torn (2)

(1 UC Berkeley / Berkeley laboratory, Earth & Planetary Science / Climate Sciences, Berkeley, California, United States of America; (2) Berkeley Lab, Climate sciences, Berkeley, California, United States of America

Earth’s background atmospheric CO2 and CH4 concentrations have been steadily rising due to anthropogenic emissions, and these increases since 1750 have implications for the radiative balance of the Earth’s atmosphere. The physics governing how atmospheric CO2 and CH4, both well-mixed greenhouse gases (WMGHGs), influence atmospheric infrared energy balance, and thus climate, are well established, but the impact of recent atmospheric WMGHG trends on the surface energy balance has not been experimentally confirmed in the field.

Using infrared WMGHG absorption bands and controlling for atmospheric temperature and water vapor, spectra from the DOE ARM Program’s Atmospheric Emitted Radiance Interferometers (AERI) yield the first direct observational evidence of the time-series of WMGHG surface radiative forcing directly attributable to recent increases in WMGHGs, in this case between 2000–2010. The time-series show a secular trend of increasing radiative forcing from both CO2 and CH4. This data record provides the first comprehensive observational evidence of upward trends in surface radiative forcing by WMGHGs, confirming theoretical predictions of the role of non-carbonatic greenhouse effect. These data support predictions of enhancements to the greenhouse effect from future WMGHG emissions.

Evolution of CO2 storage in karstic cavities by changes in climate in semiarid regions: Rull Cave (Alicante, Spain)

D. Benavente (1); C. Pla (1); C. Grossi (2); E. Garcia-Anton (3); S. Cuevaa (3); A. Fernandez-Cortes (4); S. Sanchez-Moral (3); J. Cañaveras (1)

(1) University of Alicante, Earth and Environmental Sciences, Alicante, Spain; (2) University of East Anglia, Norwich, United Kingdom; (3) CSIC, Museo nacional de ciencias naturales, Madrid, Spain; (4) Royal Holloway, University of London, Department of earth sciences, Surrey, United Kingdom

The global carbon cycle in the Earth’s surface–troposphere boundary depends on feedbacks among a number of sources and sink processes that operate on both short and long time scales. Soil and subsurface cavities in the vadose zone may contain large amounts of CO2 compared to the exterior air. CO2 concentrations in the vadose zone show significant seasonal and even daily variations, which involves the exchange of large amounts of this greenhouse gas with the lower troposphere. The main source of the CO2 contained in the caves is the organic production from
soil although the abiotic contribution can be important in warm seasons. CO2 from soil can be transported into the caves as a gas or dissolved in seepage waters and the final cave air CO2 concentration air is broadly the result of the mixing of background atmospheric CO2 with soil CO2. Tourism can also increase CO2 concentrations in cave-air by an order of magnitude. The cavities CO2 outputs are mainly due to ventilation processes that depend on cave morphology, the number and configuration of cave openings, and microclimatic relationships with the exterior climate.

Our study has been carried out in the Rull cave during two annual cycles (November 2012 - January 2015). The karstic cavity is located in the northeastern sector of Alicante province, a semiarid region on the Spanish Mediterranean coast (30 km far from the coast line). Indoor temperatures and relative humidity were measured and compared to both CO2 sink and source for the whole period, although some differences were found between the two registered cycles. For the first cycle (December 2012 - November 2013), average value of indoor T and RH were 15.9°C and 97.2% respectively. Indoor T reached a maximum value of 16.6 °C. CO2 mean concentration was 2054 ppm but this value varied from 463 ppm (minimum value, registered in January 2013) to 4065 ppm (August 2013). In 2014, indoor T and RH average values were 16.1°C and 97.8% respectively but indoor T reached a maximum value of 17.2°C. Mean CO2 concentration was 1937 ppm but it ranged from 565 ppm (February 2014) to 3731 ppm (August 2014). The gaseous recharge of the cavity occurs when the outdoors temperature is higher than the cave air temperature and as consequence of the air density difference. For the second studied cycle (2014) the recharge of the cavity took place some days before than for the first cycle as outdoor temperature exceeded the temperature of the cavity slightly earlier than in 2013. This fact confirms that relationship between both temperatures is a key factor in the dynamics of this cavity. Furthermore, air cave CO2 changed for the both cycles and was closely related to rainfall. Significant contributes to biotic and abiotic processes. For the first cycle (2013) total annual rainfall was 471 mm, while it was 280 mm for 2014. Rainfall drop is mainly responsible of a lower CO2 concentration in the cavity for 2014 due to lower gaseous recharge. (i) a lower amount of soil moisture; (ii) a lower amount of seepage waters that finally reach the cavity containing dissolved CO2; (iii) when the soil–epikarst system suffers for a reduction in moisture (due to the scarce rainfalls). A major connection between the underground and the exterior environment is accomplished as consequence of an opening of the soil porous system and the fractures–fissures of the epikarst, which is responsible for a higher gaseous exchange.

The isotopic signal δ13C of CO2 is widely used as a proxy of the origin of the CO2. The light values of 813C02 inside the cavity point to an organic origin of the CO2. 813C02 average annual value for outdoor atmosphere, soil and cave are ~10.1, ~21.9 and ~22.0 % respectively. CO2 in soil was found almost constant. However, CO2 indoor values (2948 ppm) occur while the cave is in gaseous recharging (April 2014) while the lowest concentration (735.5 ppm) is found in August 2014, when the soil production is buffered due to the high temperatures and scarce water.

Results highlight the narrow existing dependence between climate conditions and CO2 dynamics in the cave–soil–atmosphere system. The output of the CMIP5 multi-model ensemble, under the RCP4.5 and RCP8.5 scenarios, predicts a relevant increase of temperature and a decrease in precipitation and relative humidity at the geographical coordinates of the cave surface throughout the current century. We are using this CMIP5 output to model the evolution of seasonal ventilation recharge pattern and a potential reduction of the CO2 storage capacity in this semiarid region.

P-1115-02

The use of GHGs as tracers of the coupling/uncoupling between natural processes and human activities in a Mediterranean Delta system

L. Cañas Ramírez (1) ; E. Vazquez, (1) ; A. ÁGueda, (1) ; P. Occhipinti, (1) ; C. Grossi, (1) ; R. Curcoll (1) ; M. Nofuentes Ramos (1) ; O. Batet, (1) ; S. Borrás, (1) ; X. Rodó (6) ; JA. Morgui (1)

(1) Institut Catalá de Ciencies del Clima, Lab atmosphere & oceans, Barcelona, Spain

Delta ecosystems are important in many environmental aspects as they act like a buffer between terrestrial and marine ecosystems. Moreover, human activities control the basing hydrology and the overall watershed economy from the water in a resource perspective. Furthermore, the Delta environmental patchiness favors a high biodiversity standing on a delicate equilibrium.

The high sensitivity of these ecosystems to small changes in environmental conditions, already under the pressure of human exploitation, might lead abrupt changes on demographic dynamics of the inhabiting species, the migrant ones and the invasive ones. Under the threats of climate change, like reduced water discharge and the consequent surface water decrease, increased temperature, increase in the incidence of droughts, etc., might amplify the effects of natural occurring cycles.

The detailed and continuous study of greenhouse gas emissions (GHGs) like CO2, CH4 and N2O as tracers of ecosystemic metabolic fluxes is a useful tool to discern the changes occurring along different temporal scales, from less than hours to years. Thus, they offer an excellent dataset to assess management, adaptation and mitigation policies on endangered deltas.

The Ebote Delta is one of the largest wetland areas (over 300 Km2) in the North–Western Mediterranean region. This area presents a high diversity of ecosystems with rice fields, natural lagoons and marshes along the shoreline, conforming a highly patched landscape. Water management plays a relevant role in agricultural activity, birdlife habitat protection and GHGs sources and sinks.

A GHGs measurement station has been established at the Ebote River Delta Natural Park with the aim of studying climate interactions between land–surface and atmosphere by means of indicators that can be used to monitor and evaluate the results of the management plans. Moreover, this initiative was supported by the framework of the Climadat project (www.climadat.es, funded by Obra Social “la Caixa”) and InGOS.

GHGs data obtained in this location provide thorough knowledge of the Ebote river delta and the coupling and uncoupling of human activities and natural cycles.

P-1115-03

A dedicated monitoring network for greenhouse gases: SNO ICOS-France

M. Delmotte, (1) ; M. Ramonet, (1) ; V. Kazan, (1) ; C. Vuillemin, (1) ; PE. Blanc (2) ; B. Burban (3) ; S. Conil, (4) ; A. Diawara (5) ; F. Gheusi, (6) ; JM. Metzger (7) ; JM. Pichon, (8)

(1) LSCE, Gif-sur-Yvette, France; (2) CNRS, St Michel l’Observatoire, France; (3) INRA, Cayenne, French Guiana; (4) ANDRA, Observatoire pérénne de l’environnement, Bure, France; (5) Université de Versailles Saint Quentin en Yvelines, France; (6) Abidjan, Physic, Ivory Coast; (7) Laboratoire d’Aérologie, Observatoire midi pyrénéens, Toulouse, France; (8) CNRS & Université de La Réunion, Oué–réunion, Saint Denis de la Réunion, France; (8) Laboratoire de Météorologie Physique, Opgc, Clermont–Ferrand, France

Greenhouse gases (GHG) have been identified as the main actors of current climate change. Evolution of the atmospheric composition will drive our future climate and it is therefore essential to increase our knowledge of the Global carbon cycle, from global to regional and/or national scale and to precisely monitor the composition of the atmosphere.

Since the pioneer CO2 observation study conducted at Mauna Loa in the late fifties, atmospheric monitoring stations have been progressively deployed over most of the earth, mainly focusing on CO2 specie. Over the last decades, a significant effort has been invested to build real operational monitoring network including more monitored species (CO2, CH4, CO, N2O) and continuous recording (instead of flasks samples). In Europe, these efforts resulted in the foundation of the Integrated Carbon Observation System (ICOS) research infrastructure which is based on a harmonized and operational monitoring network including 16 countries.

As member and contributor to the ICOS infrastructure, France has a major role on the atmospheric component of the project through the GHG national network (SNO ICOS-France) and the atmospheric thematic center installed...
at LSCE. The French monitoring network consists of 12 observation stations including ground stations and high tower equipped with several sampling levels.

We will present the French monitoring network for GHG:

- Network design and station location,
- station set up and specifications,
- instrumental set up and characteristics,
- data treatment and quality control.

We will also give some example of scientific results obtained from chosen observations within the French monitoring network, such as rainfall events, changes in synoptic events, trends and seasonal variability on long term records.

**P-1115-04**

**Methodological Discrepancies in Measuring Agricultural Greenhouse Gases for Precise Estimation of National Emissions**

ML. Khalil (1) ; B. Osborne (1)

(1) University College Dublin, Ucd earth institute, Dublin 4, Ireland

The main agricultural greenhouse gases (GHGs) – nitrous oxide (N2O) and methane (CH4) – account for 10–12% of the total greenhouse gases globally, corresponding to ~ 60% and 50% of total anthropogenic emissions, respectively. Agricultural systems are highly diversified and complex, and that measured data covering all practices are very difficult to estimate GHG emissions accurately at entity scales/system boundaries and thereby national levels, which is vital. This is to provide robust data for accounting, modeling, finding policy options and mitigation measures with confidence, leading to achieve the environmental sustainability and greater resilience in agricultural production. Special equipment, technical capacity and infrastructure required to measure actual GHG emissions from the source into the atmosphere are insufficient at global scales. These are associated with cost and complexity of methodologies as well as huge difficulty in measurement under field conditions. These result in large uncertainty due to sampling errors and the impact of soil, weather and other environmental variables including management-induced changes relative to background pools and fluxes.

Soil N2O emissions are extremely variable in time and space linking particularly to the practices that affect its fluxes in one soil alone or in association with climate/site-year more than in another. Accordingly, development and selection of existing but globally recognized methodology appropriate for a country should be chosen. It is to estimate changes in emissions accurately at the entity level but sufficiently generalizable for upscaling. There are several existing methods to measure N2O and CH4 emissions for example are: (i) intact soil cores under artificial environment without vegetation and simulated management practices, (ii) closed or open chamber measurements that are limited primarily by timing and frequency of gas samplings, (iii) automated chamber that represent a combination of ground and chamber management practices inadequately, (iv) micrometeorological shows difficulty in differentiating the impact of land use and management practices at entity/boundary scales, and (v) isotope technique, which is very delicate and expensive.

Recently, tiered measuring approaches are proposed to capture both temporal and spatial variability of agricultural GHG fluxes including livestock and manure management systems coupling with the generation of ancillary data related to key variables in these systems. For precise estimation of national GHG emissions using practice-based scaling factors, a new hybrid approach i.e. coupling model with a measurement network of stratified monitoring sites with due consideration to key factors for example soil properties, land use type, nutrient and water management and climate influencing GHG emissions is likely to be most feasible and robust way forward to minimize uncertainty. Given the regulatory roles of the key influencing factors and variables, each measurement method has its advantages and disadvantages in providing the quantity of GHG emissions closer to reality. This paper illustrates the above issues to find a universally acceptable appropriate methodology to accurately measure and monitor GHGs from agricultural systems.

**P-1115-05**

**A proposed open international standard for GHG emissions and offsets**

L. Mckee (1) ; D. Bart (2) ; M. Jackson, (3)

(1) Open Geospatial Consortium (OGC), Wayland, Massachusetts, United States of America; (2) Open Geospatial Consortium (OGC), Antwerp, Belgium; (3) University of Nottingham, Professor of geospatial science, faculty of engineering, Nottingham, United Kingdom

The diversity of carbon calculators, protocols and registries currently make it difficult to publish, discover, assess, access, aggregate, analyze and share geospatial and statistical information about GHG emissions and offsets. In recent years, facing similar diversity, the hydrology, agriculture, meteorology, ecology and bioinformatics communities have all developed consistent international open geospatial standards (WaterML 2.0, WXXM, netCDF and GeoSciML) for encoding those four types of data. Those standards are based on a shared framework of geospatial and temporal standards that make maximum use of Internet and Web technologies. GHG markets, treaties, science, and taxation and regulator regimes all await an expansion of that standards framework to encompass GHG emissions and GHG offset projects. International standards for geospatially consistent digital characterization of GHG emissions and offsets would add rigor to GHG science and management analysis and transparency to GHG transactions and compliance. The standards would also increase the value of GHG data immeasurably by fully leveraging the computational and communication power of the Internet and Web.

Virtually all of the data involved in GHG measurement and management activities has geospatial and temporal elements. The not-for-profit standards organizations Open Geospatial Consortium (OGC) and World Wide Web Consortium (W3C) are already engaged together along with ISO with many other organizations in developing a unified platform of spatial environmental standards.

We propose that public and private sector climate organizations commit a very small fraction of their budgets to developing open international encoding and interface standards that would enable efficient and effective integration of GHG data. Much of what needs to be measured and communicated has already been captured in current GHG standards, registries, protocols and calculators. The next step is to agree on common conceptual models for this data, using something like UML (Universal Modeling Language) diagrams. There will probably need to be a separate data model for each greenhouse gas, though the models will share many features and borrow significantly from standards such as WaterML 2.0. The same conceptual models would provide a basis for different but interoperable implementation standards for computing platforms such as XML, JSON and REST, or CSV.

Our talk, perhaps a keynote, would be focused on standards for encoding GHG data, but it would also show how this proposed standard or set of standards is necessary for all types of environmental accounting. We would explain the methodology for developing such standards and explain why such standards are urgently needed as we enter ‘the environmental age’.

**P-1115-06**

**The French ICOS ecosystems stations : an overview**

S. Lafont (1) ; D. Loustau (2) ; T. Tallec, (3) ; D. Bonal, (4) ; E. Cescia (3) ; A. Chabbi (5) ; S. Conil, (6) ; E. Dufrence, (7) ; S. Garrigues, (8) ; R. Joffre, (9) ; K. Klumpp (10) ; B. Longdoz, (4) ; B. Loubet, (11) ; O. Marloie (8) ; B. Mary, (12)

(1) INRA, Bordeaux- ISPA, Villenave d’Ornon, France; (2) INRA, ISPA, Villenave d’Ornon, France; (3) INRA, Montpellier, France; (4) INRA, Nantes, France; (5) INRA, Lusignan, France; (6) ANDRA, Observatoire pérenne de l’environnement, Bure, France; (7) Université Paris Sud, orsay, France; (8) INRA, Avignon, France; (9) CEFIE, Montpellier, France; (10) INRA, Urep, Clermont–Ferrand, France; (11) INRA, Grignon, France; (12) INRA, laon, France
The terrestrial biosphere interacts strongly with the climate, providing both positive and negative feedbacks due to biogeophysical and biogeochemical processes. To understand and predict the evolution of the climate, it is critical to understand both the contribution of vegetation to the greenhouse gases (GHG) and the response of the terrestrial biosphere to the changing climate.

The Integrated Carbon Observation System (ICOS), a new European monitoring network, offers a unique way of documenting and quantifying long term changes in the GHG balance of ecosystems. The ICOS research infrastructure includes atmospheric, ecosystem and marine station networks. The European station network (ESN) of ICOS is based on a large number of monitoring stations that will be maintained for the next 20 years. The ESN uses a large set of standardised instruments to perform continuous and intensive measurements of meteorological and micrometeorological variables. A central part of this measurement set is the eddy covariance measurement, that allows a continuous monitoring of the flux exchanged between vegetation and atmosphere. All together these standardised observations allow a better understanding of the functioning of ecosystems in relation to climate and management practices.

ICOS Ecosystems France, the French part of ESN is a cooperation of three research institutes: INRA, CNRS and ADEME. ICOS Ecosystems France is extensive and includes eight observation stations (4 Class 1, 4 Class 2). In addition seven associated stations also contribute to the network. The network samples a wide range of ecosystems (forest, crop and grassland), of management practices and climates (from cold mountain climate to tropical humid in Guyana, including wet oceanic and dry Mediterranean climate).

We will provide an overview of the stations and the measurement system (sensors and data flow). We will equally present the current status of the network, recent measurements and preliminary findings.

P-1115-07

Ground-based monitoring of greenhouse gases emissions over continental ecosystems: the ecosystem part of the ICOS European infrastructure

D. Loustau (1); S. Lafont (1); I. Janssens, (2); D. Papale, (3) ; R. Valentini (3); B. Gielen, (2) ; M. Op De Beek (2); TMT. Nguyen (2); R. Ceulemans, (2)

(1) INRA, ISPA, Villeneuve d’Ornon, France; (2) University of Antwerpen, Antwerpen, Belgium; (3) University of Tuscia, Viterbo, Italy.

Since the discovery in the early nineties of a missing terrestrial carbon sink in the global carbon cycle (Tans et al. 1990), there was a tremendous effort of observation of the continental part of the carbon cycle.

The most recent estimate of its magnitude proposed by the Global Carbon Project reaches 10.6 GtC CO2±2.9 in 2014. The continental ecosystems contribute to attenuate the anthropogenic greenhouse gases enhancement by 29%.

This terrestrial sink is characterized by the large amplitude of its inter-annual variations and its ample uncertainty which makes it difficult to predict the future of the continental sink of carbon.

Inversion of atmospheric concentrations in greenhouse gases (GHG) and their temporal variations combined with atmospheric transport model allows characterizing the GHG exchanges at the continental scale at typical scale of 10 to 100 km.

Point measurements of the full GHG budget at half hourly resolution together with ancillary measurements of vegetation, management practices and soil permit to characterize the biogeochemical processes involved and their drivers. They are of utmost importance for understanding the GHG cycle and its sensitivity to environmental drivers on the long term.

Thus far, however, the inhomogeneity of methods, protocols and instruments used across ground observation networks have limited strongly our capacity to detect and observe the effects of environmental changes that are assumed to provoke changes in the GHG cycle.

Indeed, the rate of pollutants deposition (Ozone, Nitrogen compounds), solar dimming, climate change and CO2 concentration enhancement not mentioning the secondary drivers are not monitored with sufficient accuracy and need to be co-located in a number of stations attributing clearly changes in the GHG budget of the main terrestrial ecosystems.

From this conclusion, the European research strategy implemented through the ESFRi roadmap was to build a new world class infrastructure having the capacity to coordinate and harmonise networks of ocean-, atmospheric- and ground-based stations equipped with identical instruments and operated according to the sale common protocols and standards, that is the ICOS infrastructure.

This communication will present the ICOS ecosystem network of stations and the Ecosystem Thematic Centre which collects and processes the measurements that are being operated across the station network. It will give few examples of the data obtained so far and show how they are being used for establishing robust GHG budgets of different ecosystems and their sensitivity to the environment, management practices and interaction.


P-1115-08

A Multi-Model Regional Decomposition of CO2 Emissions: Socio-Economic Developments vs Energy Efficiency and Carbon Intensity Improvements

MM. Malpede (1)

(1) Fondazione Eni Enrico Mattei (FEEM), Milan, Italy

This study explores the regional distribution of total CO2 emissions.


Ang (2004) shows that a difference in an aggregate indicator can be decomposed into the sum of the effects by differences in explaining factors and residual terms. Therefore changes of CO2 between time t and t-n is defined as the sum of the differences of each of the drivers and a residual term.

By making use of the Long Mean Divisia Index (LMDI) and the Refined Laspeyres Decomposition (RLD), the purpose of this study is to decompose the sum of the effects in which those components affect total CO2 emissions for different regions of the world, over time and across different socio-economic scenarios. In particular, socio-economic scenarios considered to perform this analysis are the 5 SSPs developed by National Center for Atmospheric Research (NCAR).

The reason of that is to determine the implications of each of the 4 drivers in evaluating the impacts of climate policies on global and regional economic systems and exploring the differences between short-term (2010-2030), medium-term (2010-2050) and long-run (2010-2100) effects.

By drawing data from the IIASA Database, this study considers 6 Integrated Assessment Models used to analyze climate mitigation and impact of different policies in regional economic systems, i.e. AIM-CGE, REMIND, MESSAGE, GCAM, IMAGE and WITCH and by making use of the Principal Component Analysis it evaluates their performances in explaining regional CO2 variations, and in which degree they differ.

The main findings of this study are the following:

REGIONAL VARIATIONS OF CO2 EMISSIONS:

- Index Decomposition Analysis, performed by utilizing
the LMDI method suggests a convergence and eventually divergence in total CO₂ emissions over time for developing countries with respect to advanced economies. This is mainly due to more robust GDP per capita and Population growth rates relatively to those shown by the USA and Europe.

- However this is not the case of Latin America countries which thanks to a relative high rate of carbonization and less GDP per capita and population, the growth rate is an important factor affecting average growth of total CO₂ emissions with respect to that of the USA.

**IMPACT OF EACH FACTOR IN EXPLAINING CO₂ OVER TIME AND ACROSS SCENARIOS:**

- GDP per capita and Population are shown to have a positive impact on total CO₂ emissions, in particular for developing regions. Energy Efficiency, in contrast, is the main determinant in dragging down total CO₂ emissions in different economic scenarios. This is valid for all regions considered expect for Latin America countries in which decarbonization plays the biggest role.

- While the impact of Energy Efficiency is more stagnant over time, the pattern shown by the Carbon Intensity Effect suggests an increasing trend over the course of the years. Nevertheless the implications of such components differ from region to region and scenario considered.

**PERFORMANCES OF INTEGRATED ASSESSMENT MODELS IN EVALUATING REGIONAL CO₂ EMISSION VARIATIONS:**

- Principal Component Analysis suggests that although the 6 models achieved a considerable degree of homogeneity, they feature differences stemming from the components of Primary Energy (i.e. Fossil, Biomass, Nuclear and Non Biomass Renewables), while showing a similar pattern for Carbon Intensity, Population and GDP per capita. In particular IMAGE and MESSAGE incorporate more optimistic assumptions on total CO₂ variation in the short-term relatively to WITCH, GCAM, AIM and REMIND.

**P-1115-09**

**Influence of Tropospheric and Stratospheric Air Pollution on Climate Change over the Indian Subcontinent**

S. Palve (1)

(1) Research Scholar University of Pune, PUNE, MAHARASHTRA, India

India is home to an extraordinary variety of climatic regions, ranging from tropical in the south to temperate and alpine in the Himalayan north, where elevated regions receive the substantial winter snowfall. India is characterised by strong temperature variations in different seasons ranging from mean temperature of about 10°C in winter to about 32°C in summer season. Monsoonal and other weather conditions in India can be wildly unstable, episodic droughts, floods, cyclones, and other natural disasters are sporadic, but have displaced or ended millions of human lives. Ongoing and future vegetative changes and current sea level rises and the attendant inundation of India’s low-lying coastal areas are other impacts, current or predicted, that are attributable to global warming. Over the past two decades India has undergone rapid industrialization and economic growth and increasing emissions of gaseous pollutants. The main tropospheric pollutants (O₃, NO₂, CO, formaldehyde (HCHO) and SO₂) and two major greenhouse gases (tropospheric O₃ and methane (CH₄)) and important parameters of aerosols, which play a key role in climate change and affecting on the overall well-being of subcontinent residents. In the light of considering these facts this paper aims to investigating the possible impact of air pollutants on climate change over the subcontinent. Atmospheric aerosols can impact the local and regional radiation heat budget. Black carbon aerosols absorb incident solar radiation and heat the atmosphere more effectively than dust, sulfates, and organic carbons, which reflect more radiation and cool the atmosphere. The population 1.25 billion in India has led to a significant demand on the natural resources. While, livestock, air pollution by biogenic sources, as well as agricultural activities, burning of dung, and crop waste are the primary contributors of aerosols in rural areas of India. Satellite derived column aerosol optical depth (AOD) is a cost effective way to monitor and study aerosols distribution and effects over a long time period. Aerosols have an impact on cloud formation process largely affecting monsoonal rainfall distribution over Indian subcontinent especially in the Ganga basin. Indo-Asian aerosols have impact on radiative forcing that cause negative forcing (cooling) at surface and positive effect (warming) at top of atmosphere. AOD is found to be substantially increasing in the Ganga basin. Indo-Asian aerosols have impact on radiative forcing that cause negative forcing (cooling) at surface and positive effect (warming) at top of atmosphere. AOD is found to be substantially increasing in the Ganga basin. Indo-Asian aerosols have impact on radiative forcing that cause negative forcing (cooling) at surface and positive effect (warming) at top of atmosphere. AOD is found to be substantially increasing in the Ganga basin.

**P-1115-10**

**A Roadmap for Monitoring GHG Emissions Reduction in Brazil**

M. Poppe, (1) ; M. Rocha, (2)

(1) Centre for Strategic Studies and Management in Science, Technology and Innovation (CGEE), Sustainable development, Brasilia – DF, Brazil; (2) Fabrica Ethica, Piracicaba – SP, Brazil

The Brazilian government is developing and implementing a modular system to monitor, analyze and manage the greenhouse gases (GHG) emissions reductions achieved through the National Mitigation Plans (NMP) – SMMARE (in Portuguese: Sistema Modular de Monitoramento e Acompanhamento das Reduções das Emissões de Gases de Efeito Estufa).

Since the NMP are in different stages of implementation and are substantially different in terms of mitigation actions, each NMP will have a Monitoring Module (MM) that will be implemented in different points of time. All MM will be based on the methodology for Greenhouse Gas Inventories, taking into consideration relevant national circumstances.

CGEE (a non-profit organization with the mission of rendering Science, Technology and Innovation as Brazil’s best allies for economic growth, competitiveness and well-being) has coordinated, under the supervision of the Environmental Ministry, a group of experts with extensive experience in national GHG inventory planning, implementation and review, to develop each MM.

SMMARE was conceived during a one-year process with extensive and continuous dialogue with all the Ministries responsible for each NMP; and is being implemented based on 2 scenarios:

- Possible scenario: in which, based on the existing data and/or data that can be easily obtained, the monitoring of GHG emissions reduction could be done in the short term at the national level.

- Ideal scenario: in which it would be necessary to improve the data collection in order to make the GHG emissions
reduction monitoring in a more disaggregated level (e.g. emissions reduction at the territorial–unit level due to decrease in deforestation; emissions reduction at the plant level due to implementation of a specific technology; etc.).

Finally, SMMARE is designed to be a tool to help the international consultation analysis (ICA) process to be conducted under UNFCCC, with the aim to increase the transparency of mitigation actions and their effects.

An Example of a Monitoring Module – One of the NMP that have been implemented and is obtaining good results is the Action Plan for Protection and Control of Deforestation in the Amazon (PPCDAm), under the responsibility of the Ministry of Environment. Since its implementation in 2004, deforestation rates in the Amazon region have been decreasing at an average rate of 8% reduction per year (2012). With the aim of monitoring the GHG emissions reduction associated with the actions implemented by the PPCDAm, a specific MM is being developed based on a generic spatially explicit modeling framework to estimate carbon emissions from deforestation developed by the Brazilian Institute for Space Research (INPE–EM). An indicator for monitoring the GHG emissions reduction achieved by PPCDAm will be tons of CO2 reduced per hectare of avoid deforested areas. Preliminary results indicated that the total potential CO2 emission reduction achieved by PPCDAm will be around 580 million tones by 2020, with an average value of 200 tones of biomass per hectare.

**P-1115-11**

Greenhouse gas emissions from energy consumption and mitigation of a mining project in Padcal, Benguet Province, Philippines

E. Racelis (1); D. Racelis, (1)
(1) University of the Philippines Los Banos, College of Forestry and Natural Resources, College, Laguna, Philippines

The mining industry is one of the most economically important sectors in our society particularly for developing countries. It is a major foreign exchange earner and provides employment opportunities to thousands of people. However, the industry is viewed as among the primary causes of environmental degradation. One of the potential adverse impacts of mining operation is greenhouse gas emission that contributes to global warming and climate change. To minimize the impacts, accurate assessment of greenhouse gas emissions is necessary not only to identify them but more importantly to find ways to minimize if not totally avoid their adverse consequences.

A study was conducted to determine the amount of GHG emissions from mining operation focusing on energy consumption. Using 2014 as base year, the study showed that under Scope 1, the fuel used for both mobile and stationary sources amounted to a total of 5,081,995.10 liters of diesel and 6,317.00 liters of gasoline. The total fuel usage has an equivalent amount of 14,021.09 Mg of CO2e. While under Scope 2, the company consumed a total of 280,142.01 megawatts of electricity in its mine and milling operations including those of ancillary services and staff housing needs. The amount of electricity consumed has an equivalent of 238,400.85 Mg of CO2e emissions.

To sum it up, the company’s GHG emissions from energy usage yielded a total of 252,421.94 Mg of CO2e. This would mean that the project has to mitigate their CO2 emissions. One of the easiest and economical ways of sequestering carbon is through plantation maintenance and establishment in which the company has intensively done since then. A Pinus kesiya plantation has an average sequestration rate of 12.7 Mg C ha−1 year−1 or 46.57 Mg C per 3.5 hectares. The signals are characterized by a high year-to-year variability (up to 6 µmol.mol−1 for CO2), with a strong correlation between most of the stations. The latest winter (2013-2014) shows relatively low gradients at all sites. Finally, the amount of GHGs emitted by mining operation under Scope 1 and 2 is found to be 79,592.78 and 249,345.44 respectively. This shows that the project has to mitigate its GHG emissions to be compliant with the existing standards.
Assessing the role of megacities on atmospheric CO2: results for Paris from the CO2-MegaParis project, France

I. Xuereb-Remy (1); E. Dieudonné (1); C. Vuillemin (1); M. Lopez (1); C. Lac (2); M. Delmotte (1); F. Ravetta (3); O. Perrussel (4); F. Blanc (1); G. Broquet (1); M. Schmidt (5); B. Bonsang (1); C. Ampe (7); L. Ammourea (6); V. Gros (1); A. Baudic (1); B. Bonsang (1)

(1) LSCE, Irfp, Gif-sur-Yvette, France; (2) CNRM, Toulouse, France; (3) LATMOS, Irs, Paris, France; (4) AIRPARIF, Paris, France; (5) IUP, Heidelberg, Germany; (6) LSCE, Irfp, Gif sur Yvette, France; (7) Airparif, Paris, France

On average, atmospheric CO2 increases in the atmosphere at a rate of about 2 parts per million (ppm) per year, due to the accumulation of about half of the anthropogenic CO2 emissions in the atmosphere (mostly from the combustion of fossil fuels), while the other half is being re-absorbed by the ocean and the continental biosphere. Today, more than 70% of global fossil-fuel CO2 emissions come from punctual sources such as megacities. Paris is the third megacity in Europe and it emits about 15% of the total French emissions, while it covers only less than 2% of the national territory. Currently, most of the estimates of urban CO2 emissions are given by bottom-up CO2 emissions inventories, which rely on activity proxies and benchmarked emission factors. The associated uncertainties can be as high as several tenths of percents, especially when it comes to discriminate the CO2 urban emissions by emission sectors. Therefore, there is an urgent need for developing new methods to better Monitoring, Reporting and Verifying (MRV) CO2 emissions from megacities, dedicated to provide robust results to policy makers for taking efficient decisions and actions in matter of controlling CO2 anthropogenic emissions and mitigating climate change. Since 2009, the CO2-Megaparis project aims to quantify CO2 emissions from Paris using top-down approaches based on a synergy between atmospheric observations and modeling.

For the first time, a mini–network of 3 greenhouse gases (GHG) monitoring stations was developed by LSCE in Paris agglomerometry within the infrastructure of the regional air quality monitoring network. One of our urban station was located on top of the Eiffel tower above Paris megacity. The analysis of one year of data showed that Paris CO2 emissions lead to a mean increase of the atmospheric CO2 concentration in the mid–afternoon of 2 to 3 ppm, and a strong seasonal cycle. The emissions from the point–dependent: the CO2 urban plume is characterized by a very large spatio–temporal variability and can reach about 60 ppm at low windspeeds on top of the Eiffel tower. In addition, analysis of the annual CO2 emissions inventories from the CO2-Parisian project, based on lidar facilities revealed that due to the effect of the urban heat island, the boundary layer height (that can be seen on the first degree as the man dilution factor of CO2 emissions in the atmosphere), is 10 to 40% time higher in Paris than in surrounding rural areas: this is an important result that supports the implementation of urban canopy models in future fine scale urban CO2 modeling framework. A synthesis of the different results will be presented, as well as an attempt of defining the strengths and weaknesses of the atmospheric approach to identify urban CO2 emissions inventories. Further studeris (MultiCO2 – IPSL, Le CO2 parisien – Ville de Paris 2030, CarboCount-City – KIC Climat...) will also be mentioned.

Transferring concern with climate mitigation to Institutional Sustainability: A case study applying carbon accounting as a tool for resource management in a desert environment

X. Tarabieh (1); R. Tuttwiler (2); T. Jaskolski (2); M. Rauch (3)

(1) The American University in Cairo, Construction and Architectural Engineering Dept, New Cairo, Egypt; (2) The American University in Cairo, Research institute for a sustainable environment, New Cairo, Egypt; (3) The American University in Cairo, Sustainability office, New Cairo, Egypt

As a result of climate change and the potential risk of global warming, there is an emerging interest across academic institutions to develop a comprehensive inventory of greenhouse gas emissions. Higher education institutions are often faced with the challenge to develop a process that will accurately assess the campus' resource consumption in a timely, economical, and informative manner. This type of assessment is not typical and relies heavily on the availability of data and institutional capacity to carry out the work. This paper reports the findings of a study and presents a procedure for benchmarking against peer institutions and establish the institutional mechanisms to sustain this type of data intensive work. In response to the previous principals and faced with the need of environmental changes in a desert environment, the American University in Cairo (AUC) recently completed the first phase of carbon accounting and issued a Carbon Footprint Report which highlights the adopted by the sustainability team to reduce energy consumption on campus. The report measured the University's carbon footprint, which is the annual total of carbon dioxide (CO2) and other significant greenhouse gases released into the atmosphere as a result of daily activities and campus operations. AUC was the first higher education institution in the Middle East and North Africa to conduct such a comprehensive study of its own impact on climate change. As part of its ongoing efforts to maintain and improve its operational sustainability, AUC has witnessed a one-third reduction in energy consumption on the New Cairo campus over the past two years, decreasing the cost of utilities by 35%, thanks to an energy–saving plan designed and implemented by the University’s sustainability team. This proposal presents the method, challenges, strengths and areas of improvement of the method used and outlines the present strategies developed to manage the campus resources as a result of this exercise. It also presents the efforts taken to institutionalize the method so it becomes campus culture and to transition the work from research to a daily practice.
Observational constraints on biogeochemical feedbacks
C. Le Quéré (1)
(1) University of East Anglia, Tyndall Centre for Climate Change Research, Norwich, United Kingdom

Tremendous efforts are underway to use a wider range of observations to inform model projections. Efforts range from enhanced coordination of repeat observations, the collection of quality controlled data in public databases, the development and application of models to project changes in the 21st century and beyond. This presentation will be based on the ‘Global Carbon Budget’ annual update by the Global Carbon Project. It includes an assessment of the annual change in land and ocean carbon sinks from three ocean data products, seven ocean models, eight dynamic global vegetation models, three atmospheric inversions, plus indirect constraints from CO2 emissions and measured atmospheric CO2 growth rate. The presentation will also include additional data and model analysis from the marine environment and discuss the marine biogeochemical feedbacks related to ocean deoxygenation and to the response of marine ecosystems to climate change and ocean acidification.

Biogeochemical feedbacks to climate change: Insights into soil moisture controls on soil heterotrophic respiration
C. Chenu (1); F. Moyano (2); P. Garnier (3); I. Virto (4)
(1) Agroparistech, Umr ecosys, Grignon, France; (2) CNRS, Bioemco, Grignon, France; (3) INRA, Umr ecosys, Grignon, France; (4) Universidad Pública de Navarra. Escuela Superior de Ingenieros Agrónomos, Departamento de ciencias del medio natural, Pamplona, Spain

Soils contain the largest C terrestrial pool and even small changes in soil organic C (SOC) can have a significant impact on the atmospheric CO2 concentration, which may thaw and decompose more rapidly as a result of climate warming. While the effect of temperature on soil C mineralization has been the subject of much work and considerable debate, much less attention has been paid to the effect of changes in water regime, another predicted component of climate change. However, soil moisture has a key role in regulating soil respiration. Here, we synthesise work relating the relation between soil moisture and soil C dynamics, focusing on the underlying mechanisms, on the interaction with soil properties and other components of global changes, and discuss how mechanisms and the complexity of soils can be integrated into models.

The effect of soil moisture is complex to predict because, unlike that of temperature, it is not a key driver of soil heterotrophic respiration. Heterotrophic soil respiration is a complex, non-linear process and is highly sensitive to changes in soil moisture. It is strongly dependent on soil conditions and is strongly influenced by other components of the carbon budget such as plant photosynthesis and soil respiration. The effect of soil moisture on heterotrophic respiration is strongly influenced by soil characteristics. Soil moisture effect on heterotrophic respiration is represented in most current carbon cycle models by empirical functions, which are often based on limited experimental data. We performed a data-driven analysis of soil moisture respiration relations and showed how these are consistently affected by soil properties such as clay content, organic C content, bulk density. We developed new models of soil moisture effects on the effects of soil moisture, soil organic carbon and bulk density which improve the functions currently used in different soil biogeochemical models.

Partially responsible for the present state of knowledge may be the idea that, in biogeochemical models, time- and spatially averaged or approximate relationship of microbial activity with moisture is sufficient to reliably predict C fluxes. But soil microorganisms live in a complex 3-D framework of mineral and organic particles defining pores of various sizes, more or less inter-connected, which result in a variety of relevant descriptors of soil perspectives in this area are based on mechanistic approaches, where theoretical linkages between substrate and gas diffusivity in soil pores and heterotrophic respiration are explored in different soil matrices. The new generation of biogeochemical models is based on the explicit representation of soil architecture at a fine scale, which provides in-depth mechanistic understanding, and should help to better constrain models. Metabolic characteristics to improve how larger scale models account for the effects of soil moisture.

The complex interplay between biological, biogeochemical and physical processes is apparent when considering the variability of soil C storage upon a widely used cropping practice: not tillage, where soil moisture also regulates the flows of C between soil litter and mineral layers. The interactions between soil moisture and other components
of global change, i.e. land use, cropping practices, temperature, will also result in biogeochemical feedbacks to climate change.

O-1116-01

Positive future climate feedback due to changes in oceanic DMS emissions

J. Tijputra (1); K. Six, (2); Ø. Seland (3); C. Heinze (4)

(1) Uni Research, Uni climate, Bergen, Norway; (2) Max Planck Institute for Meteorology, Hamburg, Germany; (3) Norwegian Meteorological Institute, Oslo, Norway; (4) University of Bergen, Geophysical institute, Bergen, Norway

The global ocean is the largest source of dimethylsulfide (DMS) produced by phytoplankton and is released to the surface ocean if cells are degraded. Once it enters the atmosphere, it might contribute to the nucleation particles important for cloud formation, which then affect the Earth’s radiation budget and climate. Future global warming and ocean acidification is projected to alter marine DMS production and emission. However none of the models assessed in the last IPCC report includes the DMS–climate feedback.

Recent study indicated that under high CO2 emissions future, the oceanic DMS emission is projected to decrease by about 2-2.5% by 2050. On the other hand, the latter issue requires a fuller consideration of water flow paths within permafrost landscapes. Given the potential for large soil carbon losses, it may be unlikely that these could be compensated for by increased plant growth, at least in tundra ecosystems where plant biomass is low. There does though remain the potential for increased soil carbon inputs from plants to reduce rates of soil carbon losses. On the other hand, rates of methane production from thawing permafrost may not be as high as first predicted. Rather, the direct effect of climate warming on rates of methanogenesis associated with the decomposition of organic matter may cause the inputs in northern wetlands, is likely to be more important.

O-1116-02

How much carbon dioxide and methane will be released from thawing permafrost soils?

L. Hartley (1); C. Estop Aragonés (1); M. Cooper (1); J. Fisher (2); C. Schaedel (3); L. Street (4); A. Thierry (5); D. Charman (1); M. Garnett (6); J. Murton (7); G. Phoenix (2); P. Wooley (3); and K. Wilbur (5)

(1) University of Exeter, Geography, College of Life and Environmental Sciences, Exeter, United Kingdom; (2) University of Sheffield, Animal and plant sciences, Sheffield, United Kingdom; (3) Northern Arizona University, Center for Ecosystem Science and Society, Flagstaff, AZ, United States of America; (4) Heriot Watt University, School of life sciences, Edinburgh, United Kingdom; (5) University of Edinburgh, School of geosciences, Edinburgh, United Kingdom; (6) NERC, Radioisotope lab, University of Edinburgh, United Kingdom; (7) University of Sussex, Geography, Chichester, United Kingdom; (8) Northern Arizona University, Department of biological sciences, Flagstaff, AZ, United States of America

High northern latitudes are predicted to warm rapidly during the 21st century. The tundra, boreal forests and peatlands found in these regions are recognised to contain substantial stores of organic matter. Permafrost soils are particularly important in this context, storing as much carbon as all the rest of the world’s soils put together, and more than twice as much carbon as the atmosphere. The PAGES2k data show that warming in the Arctic and Boreal will lead to a reduction in permafrost extent. However, while some estimates indicate that carbon release from thawing permafrost soil could be the single most important climate–carbon cycle feedback, the AR5 report also emphasises that there is low confidence in predicting rates of soil carbon loss, and also whether the carbon will be released mainly as carbon dioxide or the more powerful greenhouse gas, methane. Importantly, the permafrost feedback is not currently included in the models evaluated in the IPCC CMIP programme, and thus a potentially critical feedback is missing.

This presentation will focus on how recent studies, making detailed in situ observations, and running manipulative field and laboratory experiments, have improved understanding of the permafrost feedback. In particular, this presentation will: 1) outline the potential for different high–latitude plant communities, including understudied groups such as mosses, in both controlling rates of thaw and potentially mitigating against some of the expected carbon release, 2) outline the important role radiocarbon dating has played in detecting the contribution of the decomposition of old, previously–frozen organic matter to rates of carbon release following permafrost thaw, and 3) discuss the potential for substantial amounts of permafrost carbon to be released in the form of methane.

Research has shown that in boreal forest, thick moss layers may insulate soils to such an extent that disturbances (e.g. fire) may be required before warming promotes deep permafrost thaw. Therefore, tundra and peatland ecosystems may thaw more rapidly due to wetter conditions or reduced thickness of insulating moss layers. Overall, it appears that there is indeed considerable potential for increased carbon dioxide production from thawing permafrost, especially from highly organic soils, and there are many firsts yet to be made to fully understand the processes and rates that these could be.

O-1116-03

Biomass burning in northern sub-Saharan Africa and associated changes in environmental and climate variables

C. Ichoku (1); L. Ellison, (2); C. Gatebe, (3); R. Poudyal, (2); T. Matsui, (4); E. Willmot, (5); T. Gabbert, (6); J. Wang, (7); Y. Yue, (7); R. Damoah, (3); J. Lee, (8); J. Adegoke, (8); J. Bolten, (1); F. Polielli, (1); E. Wilcox, (9); F. Hosseinipour, (9); S. Habib, (1); C. Okonkwo, (10); F. Engelbrecht, (11)

(1) NASA Goddard Space Flight Center, Earth sciences division, code 610, Greenbelt, MD, United States of America; (2) NASA Goddard Space Flight Center, Science systems & applications, inc., Greenbelt, MD, United States of America; (3) NASA Goddard Space Flight Center, Science systems space research association (usra), Greenbelt, MD, United States of America; (4) NASA Goddard Space Flight Center, Earth system science integration (essi), Greenbelt, MD, United States of America; (5) Vanderbilt University, Nashville, TN, United States of America; (6) South Dakota School of Mines & Technology (SDSMT), Rapid City, SD, United States of America; (7) University of Nebraska, Lincoln, NE, United States of America; (8) University of Missouri, Kansas City, MO, United States of America; (9) Desert Research Institute (DRI), Reno, NV, United States of America; (10) Toward Understanding the Atmosphere of the United States of America; (11) Centre for Scientific and Industrial Research, Natural resources and the environment, Pretoria, South Africa

One of the most vulnerable tropical regions of the world is the northern sub-Saharan African (NSSA) region, which is bounded on the north and south by the Sahara and the Equator, respectively, and stretching East-West across Africa. This is so because of the highly active
Constraining the strength of the terrestrial CO2 fertilization effect in Earth system models

V. Arora (1)
(1) Canadian Centre for Climate Modelling and Analysis, Environment Canada, Victoria, Canada

The response of the global carbon cycle to future atmospheric emissions of carbon dioxide (CO2) is paramount to projecting the future atmospheric CO2 concentrations and associated climate change. However, the current generation of Earth system models (ESMs) show widely varying responses of the global carbon cycle to future increases in anthropogenic CO2 emissions. A large fraction of the differences in ESM response is due to the land carbon cycle. The response of the ocean carbon cycle, to changes in atmospheric CO2 and changing climate, is much more consistent across ESMs. Over land, the CO2 fertilization effect is biggest source of uncertainty that contributes to the large differences in response of the land carbon cycle. Here, using results from the three generations of the Canadian Earth System Model (CanESM1, CanESM2, CanESM2-4.2) it is shown that the net land carbon uptake over the historical period and the amplitude of the annual cycle of the atmospheric CO2 concentration may be used towards to constrain the strength of the CO2 fertilization effect. Uncertainty exists in land use change emissions over the historical period, and thus the estimate of historical land carbon uptake, and monthly global atmospheric CO2 data back to 1960. A strong terrestrial feedback is being utilized to investigate these multiple processes and to establish possible links between them. We are finding appreciable relationships between biomass burning and many of the above-listed ECVs. In this presentation, we will discuss interesting results as well as the path toward improved understanding of the interrelationships and feedbacks between the water cycle components and the environmental change dynamics due to biomass burning and related processes in the NSSA region.
Is Ocean really a source to atmospheric CO2 during cyclones in the Arabian Sea?

K. Chakraborty (1) ; S. Prakash (2) ; A. Paul (2)

(1) Indian National Centre for Ocean Information Services (INCOIS), Information Services and Ocean Sciences Group (ISO), Hyderabad, India; (2) Indian National Centre for Ocean Information Services (INCOIS), Information services and ocean sciences group, Hyderabad, India.

The enhanced biological production, and associated regeneration, leads to higher pCO2 in the sea water compared to atmosphere and ocean becomes a source of atmospheric CO2 (Sarma et al., 2008) during such events. Cyclone induced productivity intensify this source. Byju et al., (2011) reported that Phyan associated net CO2 flux to the atmosphere was 0.123 Tg C. We have employed a coupled 3-D bio-physical model, ocean general circulation model ROMS with an ecosystem model, to study whether Ocean is really a source to atmospheric CO2 during cyclones in the Arabian Sea. It is observed that the storm has a significant effect on the thermocline and mixed layer depth with high chlorophyll concentration in the storm influenced region. The high concentration of chlorophyll appeared as a bloom over an area of approximately 150 km in diameter along the storm passage. It is observed that the thermocline shoals the storm passes and this shoaling of the thermocline caused entrainment of nutrients in upper 50 meters which triggers high biological productivity. The 50 meter vertically integrated primary production during three different cyclones (Cyclone D1A, Tropical storm 05A and Tropical Storm PHYAN) was estimated in terms of carbon using the model along the track of the cyclone/storm. The net sequestration of carbon during different cyclones vary from 0.11 Tg C, 0.16 Tg C and 0.125 Tg C, respectively. Our study, in conjuction with Byju et al., suggest that ocean is not a source to CO2 to the atmosphere during cyclones but more such study is required to ascertain whether the ocean acts as a sink during such events.

The long-term effect of short-lived species through the climate-carbon feedback

T. Gasser (1) ; P. Ciais (1)

(1) ISCE, Gif-sur-Yvette, France

There are two types of carbonates in soils: lithogenic or primary carbonates, and pedogenic or secondary carbonates. The formation of the later depends on the availability of bicarbonates (HCO3-) and cations in the soil solution. When bicarbonates present in the soil solution, the result of the reaction of CO2 from soil respiration, the formation of pedogenic carbonates can be considered a net CO2 sink. Carbonates dynamics in soil are however complicated to depict because in addition to the source of carbonates (when new carbonates, bicarbonates dissolved in incoming water and the soil atmosphere) and cations, the conditions for precipitation and/or dissolution and leaching are continuously changing. From a global perspective, these conditions can be considered at steady state in a given place when relatively long periods of time (f.e. one year) are considered, and local climate and soil conditions do not change.

However, when the annual soil water balance changes, alterations in the concentration of bicarbonates can be expected in a short period of time because of the solubility of carbonate minerals. In this context, human–induced changes, such as the implementation of irrigation, can accelerate the dissolution and precipitation cycles of soil carbonates. In addition, irrigation stimulates the soil biological activity and biotic CO2 generation and also irrigation water can be an external source of cations and bicarbonates. For this reason, studying the evolution of carbonates in dryland agricultural soils converted to irrigation can help to understand the extent of this change in terms of carbonates availability. The complexity of biogeochemical interactions makes modelling a useful and interesting tool.

The purpose of this work was to evaluate the variations of carbonate concentrations in the topsoil of a semi–arid Mediterranean agricultural soil after the implementation of irrigation. Two adjacent plots were selected for this study: one under dryland conditions with wheat since at least 56 years and another under irrigation conditions with corn for 7 consecutive years. The plots were located in the same soil unit (Calclic Cambisol) in Funes (Navarra, Spain). Numerical simulations of carbonates concentrations, precipitation and precipitation were performed with PHREEQC for the evaluation of the geochemical interactions between the soil, the soil solution and irrigation water, for a simple model based in the monthly water balance and the observed concentrations in the soil solution and irrigation water. In addition, a sensitive analysis was developed in order to investigate the potential impact of the type of crop, salt concentrations in the irrigation water and partial CO2 pressure due to soil respiration. Finally, for the validation of the model, samples of the irrigated and non-irrigated plots were analyzed for their carbonate content and isotopic composition (δ13C).

Simulated values were consistent with the observed values of carbonates concentrations and isotopic signature of the soil samples. The simulation results also suggested that the amount of new precipitated carbonates and the amount of carbonates leached varies with the salt concentration in the irrigation water. The partial CO2 pressure of the type of crop. The most sensitive parameter was the partial CO2 pressure of the soil solution. The modelling results showed annual values of carbonates–C leaching around hundreds of kg/ha in the studied area under irrigation.

This study showed that in a relatively short period of time (seven years) the differences observed in the inorganic C budget of the agricultural soil studied could be significant in relation to the total soil C budget. Irrigation could therefore have an important effect in soil fractions of carbonate-rich soils and this should be taken into consideration in regional-scale studies.

The great climate change and the fuzzy C sink: how irrigation can change soil carbonates dynamics

I. S. De Soto (1) ; I. Virtó (1) ; P. Barré (2)

(1) Universidad Pública de Navarra. Escuela Superior de Ingenieros Agroquímicos, Departamento de Ciencias del Medio Natural and production; (2) ISCE, Gif-sur-Yvette University, Laboratoire de géologie de l'ens, Paris, France.

There are two types of carbonates in soils: lithogenic or primary carbonates, and pedogenic or secondary carbonates. The formation of the later depends on the availability of bicarbonates (HCO3-) and cations in the soil solution. When bicarbonates present in the soil solution are the result of the reaction of CO2 from soil respiration, the formation of pedogenic carbonates can be considered a net CO2 sink. Carbonates dynamics in soil are however complicated to depict because in addition to the sources of carbonates (when new carbonates, bicarbonates dissolved in incoming water and the soil atmosphere) and cations, the conditions for precipitation and/or dissolution and leaching are continuously changing. From a global perspective, these conditions can be considered at steady state in a given place when relatively long periods of time (f.e. one year) are considered, and local climate and soil conditions do not change.

However, when the annual soil water balance changes, alterations in the concentration of bicarbonates can be expected in a short period of time because of the solubility of carbonate minerals. In this context, human–induced changes, such as the implementation of irrigation, can accelerate the dissolution and precipitation cycles of soil carbonates. In addition, irrigation stimulates the soil biological activity and biotic CO2 generation and also irrigation water can be an external source of cations and bicarbonates. For this reason, studying the evolution of carbonates in dryland agricultural soils converted to irrigation can help to understand the extent of this change in terms of carbonates availability. The complexity of biogeochemical interactions makes modelling a useful and interesting tool.

The purpose of this work was to evaluate the variations of carbonate concentrations in the topsoil of a semi–arid Mediterranean agricultural soil after the implementation of irrigation. Two adjacent plots were selected for this study: one under dryland conditions with wheat since at least 56 years and another under irrigation conditions with corn for 7 consecutive years. The plots were located in the same soil unit (Calclic Cambisol) in Funes (Navarra, Spain). Numerical simulations of carbonates concentrations, precipitation and precipitation were performed with PHREEQC for the evaluation of the geochemical interactions between the soil, the soil solution and irrigation water, for a simple model based in the monthly water balance and the observed concentrations in the soil solution and irrigation water. In addition, a sensitive analysis was developed in order to investigate the potential impact of the type of crop, salt concentrations in the irrigation water and partial CO2 pressure due to soil respiration. Finally, for the validation of the model, samples of the irrigated and non-irrigated plots were analyzed for their carbonate content and isotopic composition (δ13C).

Simulated values were consistent with the observed values of carbonates concentrations and isotopic signature of the soil samples. The simulation results also suggested that the amount of new precipitated carbonates and the amount of carbonates leached varies with the salt concentration in the irrigation water. The partial CO2 pressure of the type of crop. The most sensitive parameter was the partial CO2 pressure of the soil solution. The modelling results showed annual values of carbonates–C leaching around hundreds of kg/ha in the studied area under irrigation.

This study showed that in a relatively short period of time (seven years) the differences observed in the inorganic C budget of the agricultural soil studied could be significant in relation to the total soil C budget. Irrigation could therefore have an important effect in soil fractions of carbonate-rich soils and this should be taken into consideration in regional-scale studies.
the radiative forcing timeseries produced for the fifth IPCC report (Myhre et al., 2013), we repeat the previous experiment, albeit this time the contribution of «climate change» is further broken-down into contributions by the various primary and secondary radiatively active species: CO2, non-CO2 greenhouse gases (e.g., ozone and aerosols. Of the 17 ppm (= 16% of 107 ppm) previously attributed to climate change, we estimate 79% are caused by non-CO2 greenhouse gases, -57% by short-lived species (ozone and aerosols), and the complementary 78% by CO2 itself.

To conclude, this study quantifies one of the indirect bio-chemical effects of aerosols on ozone, as first introduced by Mahowald (2011: doi:10.1126/ science.1207374). It provides an emission-based analysis of the causes of the change in CO2 atmospheric concentrations and the results of its radiative forcing, and to what was done for CH4 or O3 in the last IPCC report (Myhre et al., 2013). The emission-based approach complements the «traditional» concentration-based one, since it makes use of the simplifying assumptions that anthropogenic drivers of climate change that is one step closer to the political decision, albeit at the cost of an increased uncertainty as we will also show.

P-1116-07
Response of Soil Carbon Storage to Temperature and Carbon Input Variability in Earth System Models

K. Georgiou (1) ; WJ. Riley (2) ; MS. Torn 0
(1) University of California, Berkeley, California and Biomolecular Engineering, Berkeley, CA, United States of America; (2) Lawrence Berkeley National Laboratory, Climate and carbon sciences, Berkeley, CA, United States of America

Soil comprises the largest terrestrial carbon pool, containing more than double the carbon currently in the atmosphere and triple that in vegetation. Soil organic matter (SOM) is particularly vulnerable to environmental change with potential carbon-climate and carbon-concentration feedbacks resulting from soil warming, CO2 fertilization, nitrogen (N) enrichment, and precipitation. These changes also impact soil decomposition and stabilization processes, thereby threatening the soil’s capacity to serve as a carbon (C) sink. Earth system models (ESMs) currently use linear kinetics to represent soil C dynamics, and therefore lack explicit representation of the non-linear biotic and abiotic mechanisms that govern soil processes. As such, ESMs exhibit high uncertainty in their simulated current and future soil C storage. Recent studies have shown that explicit representation of microbial and mineral interactions improve estimates of current global C stocks and better capture spatial heterogeneity. These microbe-enabled SOM models also better represent non-linear responses to changes in soil temperature and C inputs (e.g., priming of old SOM in response to increased soil C inputs) that have been observed in many field and laboratory experiments.

Although recent work has explored the feasibility of incorporating microbial and mineral mechanisms into SOM models within ESMs, most of these models lack explicit representation of soil temperature (temperature, C inputs, and moisture). Omitting nitrogen cycling significantly affects simulated global priming responses to elevated CO2 concentrations, as nitrogen availability plays an important role in dictating microbial activity in nutrient-constrained environments. Thus far, microbe-enabled SOM models within ESMs have also largely ignored the effect of temporal forcing on soil C dynamics, representing seasonal and diurnal temperature, C and N inputs, and moisture with annual averages. These simplified model input assumptions, however, omit the seasonal and inter-annual fluctuations that microbial communities undergo in response to environmental conditions, greatly affecting the prediction of soil C equilibria and dynamics in ESMs. For example, the amount of soil respiration can occur during winter, while soils sampled in the summer (with different microbial composition) do not show respiration at winter temperatures. Leaf litter (primarily in the fall) and root exudates throughout the growing season support different microbial strategies depending on the type and duration of inputs. Global environmental change will affect the seasonality of these processes, which cannot be resolved by annual averages.

In this study we demonstrate that the frequency at which the system is resolved matters, i.e., that the seasonality and magnitude of temperature, and C and N inputs greatly impact the magnitude and sign of model response to climate change. We incorporate a trait-based, microbial–mineral, SOM model into the vertically-resolved Community Land Model (CLM4.5) of the Community Earth System Model (CESM) and present simulated current and future global C stocks that result from including seasonal forcing. We explicitly represent microbial diversity and physiology in our SOM model, allowing microbes with distinct temperature and C input optima to dominate decomposition at different times of the year when forced with seasonal temperature and C inputs (e.g., priming of old SOM in response to increased soil C inputs that have been observed in many field and laboratory experiments).

P-1116-08
Spatial distribution of atmospheric variability of greenhouse gases measured at the IC3 climatic stations

C. Grossi (1); R. Curcoll (1); A. ÁGueda, (1); O. Batet, (1); S. Borràs, (1); L. Cañas Ramirez (1); M. Nofuentes Ramos (1); P. Occhipinti, (1); E. Vazquez, (1); X. Rodó (1); JA. Morgui (1)
(1) Institut Català de Ciències del Clima, Barcelona, Spain

Changes in the atmospheric greenhouse gases (GHGs) content results as a combination of natural and anthropogenic factors. Understanding the GHGs composition, their atmospheric variability and its effect on climate change is necessary for mitigation and adaptation strategies. Indeed, GHGs variability is strongly related to the climatic conditions and closely dependent on the latitude.

In the framework of the Climadat project funded by Fundació Obra Social “la Caixa”, researchers at the Catalan Institute of Climate Sciences (IC3) have established an network of eight climatic stations across Spain performing continuous high-precision observations of CH4, CO2, N2O concentrations and meteorological parameters. The climatic stations are located in protected and remote areas within Spanish Natural Parks with middle latitudes ranging between 33N and 41N (Ebre River Delta, Xurés, Valderego, Gredos, Grazalema, Segura, El Estrecho and El Hierro).

Analysis of the atmospheric variability of GHGs concentration is performed at each station of the Climadat network. The study of the influence of the atmospheric circulation on GHGs observations is carried out by a source characterization of the airmasses and their pathways using experimental meteorological data, daily backtrajectories and cluster analysis. The observed GHGs concentrations at different latitudes and under different climatic conditions are analyzed and presented in this study.
Multidecadal variability of subsurface oxygenation off the Central Peruvian Coast since the nineteenth century

D. Gutierrez Aguilar (1) ; J. Cardich (2) ; C. Almeida, (2) ; R. Salvatteci, (3) ; D. Romero, (4) ; A. Sifeddine (5)
(1) Instituto del Mar del Perú, IMARPE, Dirección General de Investigaciones en Oceanografía y Cambio Climático, Callao, Peru; (2) Universidad Federal Fluminense, Niteroi, Brasil; (3) Kiel University, Institute of geosciences, Kiel, Germany; (4) Universidad Peruana Cayetano Heredia, Maestria en ciencias del mar, Lima, Peru; (5) Institut de Recherche pour le Développement – IRD, Umr locreq (ird/upmc/cnrs/mnhn), Paris, France

Subsurface and benthic biogeochemical conditions over the upper Peruvian continental margin are characterized by oxygen deficiency in the bottom waters, strong fluxes of settling organic matter and reducing conditions in the surface sediments. This research work has shown a multidecadal cooling trend in the surface waters off Central Peru, and an increase of export productivity, particularly since the 1960’s to the present, suggesting an intensification of coastal upwelling. The present study aims to reconstruct the coeval variation of subsurface oxygenation and benthic paleo-redox conditions for the last two centuries, based on laminated sedimentary records of benthic foraminiferal assemblages and redox-sensitive metals (Mo, Re, etc.) in the upper margin off Callao (12°S) and Piço (14°S). The period between the mid to the late nineteenth century, during which there was an enhanced ENSO activity and paleo-temperatures were higher, was characterized by the occurrence of massive diatom-rich sedimentation events and development of bottom anoxia. Afterwards, decadal variations marked the changes of the proxy records since the mid nineteenth century to the mid-twentieth century. Finally for the late twentieth century until the early 2000’s, redox-sensitive metal records and benthic foraminiferal assemblages exhibited a trend towards less reducing conditions in period featured a decline of organic matter sedimentation and a declining trend of siliceous sedimentation. Our findings suggest that pelagic–benthic fluxes, vertical mixing and/or subsurface ventilation are the important factors that modulate the subsurface oxygenation and benthic redox conditions in the Peruvian upwelling system.

Contribution of Carbon, Nitrogen and Climate Interactions to Terrestrial Carbon Uptake

A. Jain (1) ; S. Shu (1)
(1) University of Illinois, Urbana–Champaign, Atmospheric Sciences, Urbana, IL, United States of America

There is compelling evidence showing that terrestrial biosphere has acted as a net carbon (C) sink in recent decades. However there is a large uncertainty regarding the magnitude and location of the C sink, predominantly due to large uncertainties associated with C emissions from land use change and our limited understanding of processes affecting global climate, such as C sequestration, such as CO2 fertilization effect, impact of changing climate conditions on plant and soil respiations and the interaction of N dynamics with carbon and climate change. This presentation focuses on understanding and assessing the interactions between the C cycle, N cycle and climate and how they might impact terrestrial C sources and sinks in the context of changing global environment (particularly, increasing atmospheric CO2 concentrations (CO22), climate change, N deposition and land use change) by using a global terrestrial C–N cycle model in the modeling framework of the Integrated Science Assessment Model (ISAM). The ISAM model to be presented here has been calibrated based on in situ data (Ameriflux and LBA field campaign). The model is also evaluated with two sets of global GPP data, MODIS and FLUXNET2. Analysis on the results of this study suggests that responses of available N in terrestrial ecosystems to global environmental changes might have not significantly affected the net global amount of terrestrial C uptake over the last three decades, but these N responses have a strong influence on the spatial and temporal distribution of predicted C sequestration as are the influences of global environmental changes.

Are soil organic carbon and its decomposers sensitive to a temperature increase? New insights from long term bare fallows and consequences for the terrestrial carbon biogeochemical cycle

R. Lefèvre (1) ; P. Barré (2) ; PA. Maron, (3) ; S. Terrat, (3) ; S. Dequiedt, (3) ; T. Eglin, (4) ; BT. Christensen, (5) ; T. Kätterer, (6) ; S. Houot, (7) ; OF. Van (8) ; C. Chenu (9)
(1) University Pierre et Marie Curie, Ecosys, Grignon, France; (2) ENS/CRNS, Dpt geology, Paris, France; (3) INRA, Umr agroécologie, Dijon, France; (4) ADEME, Direction productions et énergies durables – service agriculture et forêt, Angers, France; (5) Aarhus university, Department of agroecology – soil fertility, Tjele, Denmark; (6) Swedish University of Agricultural Sciences, Department of ecology, Ultuna, Sweden; (7) INRA, Ecosys, Grignon, France; (8) INRA, Ecosys, Versailles, France; (9) AgroParisTech, Ecosys, Grignon, France

The IPCC projects a temperature increase of 0.3–4.8°C at the global scale by the year 2100 as well as longer and more frequent extreme events such as heat waves (IPCC, 2014). The impact of a temperature increase and of extreme events on the dynamics of stable soil organic carbon (SOC) and its decomposers remains a major source of uncertainty in predicting future changes in atmospheric CO2 levels.

Long-term bare fallow experiments in which plants and organic amendments were excluded for at least 25 years represent a unique research platform to examine this issue, as with increasing duration of the treatment, the proportion of stable SOC increases. This study employs soils from four experiments situated at Askov (Denmark), Ultuna (Sweden) and Grignon and Versailles (France). We used archived soils sampled at the start of the experiments and after 25, 49, 53 and 79 years of bare fallow, respectively, when the soils had become enriched in stable SOC. The samples were incubated at constant soil moisture and at four different temperatures (4, 12, 20 and 35 °C). The evolution of total CO2 and of 13C CO2 from the incubated soils was monitored for more than one year. At the end of the incubation, SOC decomposers were determined thanks to next generation sequencing techniques.

The results indicated a higher temperature sensitivity of SOC in soils enriched in stable carbon. However, we observed no relationship between the duration of the bare-fallow treatment and the temperature sensitivity of SOC. Surprisingly, the more diverse soil microbial communities linked to stable soil organic carbon were more sensitive to a temperature increase than less diverse communities linked to more labile organic carbon compounds. It provided evidence that biodiversity is not the only factor of functional stability and that functional stability might be a combination of biotic and abiotic soil characteristics.

Seasonal and inter-annual variability in wetland methane emissions simulated by CLM4Me and CAM-Chem and comparisons to observations of concentrations

L. Meng (1) ; R. Paudel, (2) ; PG. Hess, (3) ; NM. Mahowald, (3)
(1) Western Michigan University, Kalamazoo, MI, United States of America; (2) Cornell University, Earth and atmospheric sciences, Ithaca, NY, United States of America; (3) Cornell University, Ithaca, NY, United States of America

Understanding the temporal and spatial variation of...
Effects of multiple global environmental changes and fire on soil greenhouse gas emissions: feedbacks to climate change

A. Niboyet (1); B. Hungate (2); J. Brown (2); P. Dijkstra (2); J. Blankenship (3); Kj, Van Groenigen (2); X. Le Roux (4); P. Leadeley (5); L. Barthes (5); R. Barnard (6); C. Field (7)

(1) AgroParisTech, Institute of ecology and environmental sciences; (2) Northern Arizona University, Center for Ecosystem Science and Society, Flagstaff, AZ, United States of America; (3) Earth Research Institute, Emb, Santa Barbara, United States of America; (4) INRA, Laboratoire d'Ecologie et Milieu, Ingénierie, Agriculture, Marine, INRA, Université Paris–Sud, Laboratoire écologie, systématique et évolution, Orsay, France; (5) INRA, Umr agroécologie, Dijon, France; (7) Carnegie Institution for Science / IPCC WGI, Stanford, CA, United States of America.

Global environmental changes are expected to alter ecosystem carbon and nitrogen cycling, but the combined effects of these simultaneous environmental changes are poorly understood. Furthermore, little is known about the combined effects of chronic global environmental changes and ecological disturbances on ecosystem function. Here, we evaluated how these combined effects on soil emissions of greenhouse gases might be critical as they could accelerate climate change.

We assessed the responses of soil nitrous oxide (N2O) production, an important greenhouse gas, to elevated CO2, warming, increased precipitation, and enhanced nitrogen availability, as well as their interactions. An annual grassland as the top part of the Jasper Ridge Global Change Experiment (CA, USA). In addition, we took advantage of an accidental, low-severity wildfire that burned part of the region. The elevated-CO2, warming, precipitation and nitrogen supply amplifying fire effects on soil N2O emissions: emissions increased by a factor of two with fire alone and by a factor of six under the combined influence of fire, elevated CO2 and nitrogen. We then provide evidence that these responses were caused by increased microbial denitrification, resulting from increased soil moisture and soil carbon and nitrogen availability.

Our results indicate that the combined effects of multiple simultaneous environmental changes and fire can exceed the effects of any single factor. Furthermore, this study highlights the importance of understanding these interactive effects to soil greenhouse gas emissions. We acknowledge the impact of fire on these emissions and the potential of this natural disturbance to influence soil greenhouse gas emissions. However, it is clear that the combined effects of these changes are important to our understanding of soil greenhouse gas emissions and their role in the global carbon cycle.

Changing environmental controls affect the strength of the permafrost carbon feedback

C. Schaedeil (1); M. Bader, (2); E. Schuur (1); R. Bracho, (3); P. Capek, (4); B. Se (5); K. Diakova, (4); J. Ernakovich, (6); I. Hartley (5); CM, Iversen, (7); E. Kane, (8); RJ. Norby, (7); J. O’Donnell (9); T. Roy Chowdury (10); H. Santruckova, (4); G. Shaver, (11); C. Treat, (12); M. Waldrop, (12); KP. Wickland, (13); C. Knoblauch, (14)

(1) Northern Arizona University, Center for Ecosystem Science and Society, Flagstaff, AZ, United States of America; (2) New Zealand Forest Research Institute, Rotorua, New Zealand; (3) University of Florida, School of forest resources and conservation, Gainesville, FL, United States of America; (4) University of South Bohemia, Ceske Budejovice, Czech Republic; (5) University of Exeter, Geography, college of life and environmental sciences, Exeter, United Kingdom; (6) CSIRO, Division of land and water, Glen Osmond, SA, Australia; (7) Oak Ridge National Laboratory, Environmental sciences division and climate change sciences institute, Oak Ridge, TN, United States of America; (8) Michigan State University, Department of plant biology, East Lansing, MI, United States of America; (9) National Park Service, Anchorage, AK, United States of America; (10) Pacific Northwest Laboratory, Richland, WA, United States of America; (11) Marine Biological Laboratory, The ecosystem center, Woods Hole, MA, United States of America; (12) United States Geological Survey, Menlo Park, CA, United States of America; (13) United States Geological Survey, Boulder, CO, United States of America; (14) University of Hamburg, Institute of soil science, Hamburg, Germany.

As the global climate warms the Arctic is experiencing rapid increases in temperature causing permafrost (perennially frozen ground) to thaw and thereby exposing large quantities of previously frozen organic matter to microbial decomposition. High latitude ecosystems store almost twice as much carbon in soils and permafrost than what is currently contained in the atmosphere. Warmer temperatures in the Arctic will not only increase carbon emissions from previously frozen organic matter within the permafrost zone but also indirectly affect the carbon cycle through changes in regional and local hydrology. As permafrost degrades due to warming, soil drying will occur in upland ecosystems as a result of increased natural drainage as the water table moves further down. On the contrary, low lying areas can turn into anoxic environments as the topography and the underlying permafrost layer prevent runoff. These changes in soil surface hydrology and oxygen availability in permafrost ecosystems have broad impacts on the amount and form (carbon dioxide or methane) of carbon release from newly thawed permafrost and have the potential to further increase the permafrost carbon feedback. In order to successfully include the permafrost carbon feedback into models relevant to IPCC reports it is important to provide data sets that serve as constraints for them. In this study, we are providing the carbon-climate feedback from high latitude soils.
increasing temperatures and b) the changes from aerobic to anaerobic soil conditions on release from permafrost. Results from two different meta-analyses show that a 10°C increase in temperature increased carbon release by a factor of two in the three most intact and intact permafrost ecosystems (boreal, alpin, and peatland and tundra). Under aerobic incubation conditions, soils released on average 3.4 times more carbon than under anaerobic conditions which was consistent for all three intact and intact ecosystems. Even if changing for the higher global warming potential of methane one unit of soil released more than twice as much carbon under aerobic incubation conditions than under anaerobic conditions. This pan-arctic synthesis shows that carbon release from newly thawed organic matter in high latitude ecosystems is highly affected by increasing temperatures but that changes in soil moisture and oxygen availability have an even larger impact on carbon release. The permafrost carbon feedback is stronger in an aerobic environment as the faster decomposition offsets the higher heat trapping capacity of methane occurring under anaerobic conditions over a 100-year timescale.

P.1116-15

Topography and geochemistry influence methane response to permafrost thaw
L. Smith (1); M. Conrad, (2); MS. Torn (3); J. Curtis, (2); O. Chafe, (2); B. Markus (2)

(1) University of California Berkeley, Energy and Resources Group, Berkeley, CA, United States of America; (2) Lawrence Berkeley National Laboratory, Berkeley, CA, United States of America; (3) Lawrence Berkeley National Laboratory, Earth Sciences Division, Berkeley, CA, United States of America

Arctic wetlands are currently net sources of atmospheric CH4. CH4 emissions in Arctic tundra vary widely in space and time, with proximate controls—substrate availability, competition for substrate among decomposition processes, CH4 oxidation, and CH4 transport—dependent on local climate, soil, hydrology, and biology. These complex controls and high spatial and temporal variability make it difficult to characterize current CH4 processes and predict their responses to climate change. We investigated these processes in Arctic polygon tundra, across a permafrost thaw gradient from low-centered (intact) polygons to flat- and high-centered (degraded) polygons. We asked: (1) how do CH4 production and consumption vary with permafrost thaw and microtopographic feature, and (2) how do CH4 oxidation, CH4 transport processes relate to surface CH4 and CO2 fluxes? We made measurements in 3 microtopographic features (polygon centers, rils, and troughs) across the permafrost thaw gradient. Measurements included surface CH4 and CO2 concentrations, and stable isotope compositions of CH4 and DIC at 3 depths in the soil profile, and soil moisture and temperature. We found clear patterns in CH4 processes with permafrost degradation, as well as polygon feature and month. More degraded sites had lower CH4 emissions, a different primary methanogenic pathway, and greater CH4 oxidation than intact permafrost sites, to a greater extent soil moisture for temperatures. The importance of soil moisture for CH4 in intact polygons to 9 nmol m-2 s-1 in intact polygons to 9 nmol m-2 s-1 in degraded polygons. Stable isotope signatures of CH4 and DIC showed the expected shifts in methane production and CH4 oxidation in low-centered polygons, while CO2 reduction was the primary pathway in degraded polygons. We see evidence that distinct patterns of water flow and geochemistry between intact and degraded polygons contribute to these observations, through transport of redox-active species among high-centered polygon features. These findings suggest that future Arctic tundra CH4 emissions will depend not only on changes of soil moisture and inundation, but also on the effect of warming on larger-scale geomorphic, geochemical, and hydrologic factors. Wetland drainage due to ice wedge degradation may affect emissions across the landscape, even in inundated inter-polygon troughs.

P.1116-16

Feedbacks between climate change and the terrestrial biosphere
BD. Stocker (1); S. Williams, (2); IC. Prentice (1)

(1) Imperial College London, Department of Life Sciences, Ascot, United Kingdom; (2) Imperial College, Physics department, London, United Kingdom

Land ecosystems are absorbing ~25% of anthropogenic CO2 emissions but emit a range of other greenhouse-gases and indirectly regulate their concentrations in the atmosphere through the emission of chemically active compounds. Territorial greenhouse-gas emission rates and the energy exchange between the land surface and the atmosphere are sensitive to climate and atmospheric CO2 and thus represent a feedback to anthropogenic climate change. Recent research using coupled Earth System Models has demonstrated that land-based feedbacks may amplify climate change through positive feedbacks that have previously not been accounted for. Here, we present a comprehensive compilation of feedback strength estimates from individual land-mediated forcing agents (CO2, CH4, N2O, albedo, etc.) and their interactions based on observational data and Earth system modeling. Today, the dominant negative feedback arising from the CO2-stimulated land C sink compensates smaller positive feedbacks from non-CO2 greenhouse gases. Under a future business-as-usual scenario, these positive feedbacks exert an increasingly strong additional warming. Anthropogenic land use change and inputs of reactive nitrogen by atmospheric deposition and fertilizers act to further shift the balance of feedbacks towards more positive values. This may be mitigated by protection of forest ecosystems and a more efficient use of mineral fertilizers in agriculture.

P.1116-17

Modeling high-Arctic permafrost thawing impact on greenhouse gas exchange in Northeast Greenland
W. Zhang (1); E. Bo (2); G. Schurgers, (2); J. Hollesen (2); PE. Jansson (3); P. Miller (1); B. Smith (1)

(1) Lund University, Department of physical geography and ecosystem science, Lund, Sweden; (2) University of Copenhagen, Department of geosciences and natural resource management, Copenhagen, Denmark; (3) Royal Institute of Technology, Department of land and water resources engineering, Stockholm, Sweden

Frozen organic carbon stored in northern permafrost soils may become vulnerable due to the rapid warming of the Arctic. The loss of carbon through the emissions of CO2 and CH4 may imply a critical warming potential, resulting in positive feedbacks to global climate change. However, positive and negative feedback dynamics associated with thawing permafrost and ecosystem biogeochemistry on a landscape scale is still unclear. Here, we combine two contrasting modeling techniques to model the high-Arctic ecosystems in Northeast Greenland. Firstly, the Coup (Coupled Heat and Mass Transfer Model for soil-plant-atmosphere system) model is validated with three years’ measurements of active layer depth and soil carbon content. Secondly, to account for the transient impacts of climate change to potential vegetation dynamics, we employ the leaf area index, projective cover fraction and climatic forcing produced by a regional Earth system model (rCA-GUess), which simulates climate as well as vegetation dynamics, as the driving data to the Coup model to project future active layer depth and greenhouse gas exchange. Comparing to the Coup model driven with static vegetation properties of the validation period, we are able to quantify the effects of vegetation dynamics on the magnitude and timing of active layer depth, and ecosystem greenhouse gas exchange in the high-Arctic subject to the scenarios in different representative concentration pathways (RCP2.6, 4.5 and 8.5) as simulated with the regional Earth system model.
Effects of nitrogen deposition on photosynthesis of an alpine meadow ecosystem in Eastern Qinghai-Tibetan Plateau

L. Zhang (1); S. Yan (1)
(1) Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, Key Laboratory of Ecosystem Network Observation and Modeling, Beijing, China

Responses of leaf and canopy photosynthesis to global change play an important role in global carbon cycling. Due to human activities, especially the burning of fossil fuels, the extensive use of farmland ecosystem nitrogen and continuous development of animal husbandry, the nitrogen input level into ecosystem increases significantly. However, the effects of increasing atmospheric nitrogen deposition on leaf and canopy photosynthesis of grassland ecosystems in Qinghai–Tibetan Plateau are unclear. In this study, we measured leaf nitrogen content, photosynthesis, and leaf area index in an alpine meadow ecosystem in Eastern Qinghai–Tibetan Plateau, based on a multi-form N addition experiment. Maximum rates of carboxylation (Vcmax) and electron transport (Jmax) were calculated from A–Ci curves measured with an LI-6400 portable photosynthesis system. The results showed that leaf nitrogen content in Stipa aliena growing with a high-level nitrogen input (40 kg N ha⁻¹ yr⁻¹) increased by 6.2% and 9.7% in 2012 and 2013. Vcmax and Jmax at 25°C increased by 46.5% and 39.8% in 2012, 37.9% and 25.4% in 2013, respectively. Meanwhile, leaf area index of the alpine meadow ecosystem also had an increase of 45.0% in 2012 and 21.9% in 2013. Positive effects of nitrogen addition on leaf nitrogen content, leaf photosynthetic capacity, and canopy leaf area undoubtedly resulted in an increase in gross primary production of the alpine meadow ecosystem.

Carbon Cycle Response to Artificial Atmospheric Carbon Dioxide Removal

K. Zickfeld (1)
(1) Simon Fraser University, Vancouver, BC, Canada

Artificial removal of carbon dioxide from the atmosphere (CDR) is increasingly discussed as a complementary approach to CO2 emission reductions, particularly in the context of stringent climate targets. The efficiency of CDR is determined by the interplay between the natural carbon sinks on land and in the ocean and atmospheric CO2 levels. Only a few studies have explored the response of the global carbon cycle to CDR. Here, we use an Earth System model of intermediate complexity – the University of Victoria Earth System Climate Model (UVic ESCM) – to explore the response of the carbon cycle to atmospheric CO2 removal under a range of idealized scenarios, which differ in the total amount and rate of negative emissions, and the initial state of the system. We perform two sets of model simulations: one where a drop in atmospheric CO2 to a target level and maintenance at that level is prescribed (P), and one where an equivalent amount of negative CO2 emissions is prescribed over a given period of time, with atmospheric CO2 left to evolve freely thereafter (E). Results indicate that for both simulation sets, CO2 outgasses from the terrestrial biosphere and the ocean during the atmospheric CO2 removal phase. The amount of outgassing is sensitive to the experimental setup (P versus E simulations) and the rate and amount of CO2 removal. For P simulations we find that the lower the target atmospheric CO2 level, the larger the outgassing from natural sinks, and the larger the negative emissions required to maintain the target level. The efficiency of CDR – defined for P simulations as the cumulative negative emissions required to achieve a unit decrease in atmospheric CO2 – is independent of the rate of removal in the long-term, but increases significantly for scenarios with larger amounts of CDR.

1117 - Understanding decadal variations in the climate system and implications for the future

K-1117-01
Global and regional climate variability: a pause for thought
E. Hawkins (1)
(1) University of Reading, Dept. of meteorology, Reading, United Kingdom

Our experience of how climate changes depends on the interaction between externally driven changes, such as those due to greenhouse gases, aerosols and volcanic eruptions, and internal climate variations, both globally and locally. The recent slowdown in global temperature rise has dramatically highlighted these interactions and challenged the climate community to understand, explain and communicate the complex issues involved.

This talk will focus on some of the history of our understanding of climate variability, the links between changes in global temperature and regional climate, and the limits on the precision with which we can make climate projections. The concept of ‘climate emergence’ will also be discussed as a useful framework to help understand the role of climate variability and to help communicate the many plausible possibilities for how regional climate may change over the coming decades.

K-1117-02
Past and future European climate trends: uncertainty due to internal variability
L. Terray (1); C. Deser (2)
(1) CERFACS/CNRS, Sciences de l'Univers au CERFACS,
The Pacific decadal oscillation, revisited

M. Newman (1) ; M. Alexander (2) ; T. Ault, (3) ; K. Cobb (4) ; C. Deser (5) ; E. Dillerenzo (4) ; N. Mantua (6) ; A. Miller (7) ; S. Minobe (8) ; H. Nakamura (9) ; N. Schneider (10) ; D. Vimont (11)

(1) University of Colorado/Cires and NOAA/ESRL/PSD, Boulder, CO, United States of America; (2) NOAA/ESRL/PSD, Boulder, United States of America; (3) Cornell University, Ithaca, United States of America; (4) Georgia Tech, Atlanta, United States of America; (5) National Center for Atmospheric Research, Climate analysis section, Boulder, United States of America; (6) NOAA/NMFS Southwest Fisheries Science Center, La Jolla, United States of America; (7) Scripps Institute of Oceanography, La Jolla, United States of America; (8) Hokkaido University, Sapporo, Japan; (9) University of Tokyo, Tokyo, Japan; (10) University of California, International Pacific Research Center, Honolulu, United States of America; (11) University of Wisconsin, Madison, United States of America.

Since its identification in the late 1990’s as the dominant pattern of North Pacific sea surface temperature (SST) variability, the Pacific decadal oscillation (PDO) has been connected both to other parts of the climate system and to impacts on natural resources and marine and terrestrial ecosystems. Variability associated with the PDO has often been confused with externally forced climate change including anthropogenic effects. Subsequent research, however, has found that the PDO is not a single physical mode of climate variability but instead largely represents the combination of three groups of processes: (1) changes in ocean surface heat fluxes and Ekman (wind-driven) transport due to the Aleutian low/anticyclone, due to both local, rapidly decorrelating, unpredictable weather “noise” and to remote forcing from interannual to decadal tropical variability (largely El Nino) via the ‘atmospheric bridge’; (2) ocean memory, processes determining oceanic thermal inertia including “re-emergence” and oceanic Rossby waves, that act to integrate this forcing and thus generate added PDO variability on decadal time scales; and (3) the changes in the Pacific–North American teleconnection system forced by the multi-year history of basin–wide Ekman pumping, manifested as SST anomalies along the subarctic front (about 40°N) in the western Pacific ocean. Thus, the PDO represents the effects of different processes operating on different timescales, with few of its apparent impacts due to extratropical SST anomalies. This talk presents a synthesis of this current view of the PDO, and discusses corresponding implications for climate diagnosis, including of PDO climate impacts and predictability (both oceanographic and atmospheric); potential physical–biogeochemical linkages of the PDO in models; the interpretation of paleoclimate multicentennial reconstructions of the PDO; and its impacts on marine ecosystems. We conclude with some suggested practices for PDO diagnosis and forecasts including investigating the potential role of the PDO in the global temperature hiatus.

Importance of Atlantic decadal variability for near-term assessment and predictability of western Amazon dry-season dry and wet events

K. Fernandes (1) ; W. Baethgen, (2) ; L. Verchot (3) ; A. Giannini (1) ; M. Pinedo-Vasquez, (3)

(1) Columbia University, International Research Institute for Climate and Society (IRI), Palisades, NY, United States of America; (2) Columbia University, International Institute for climate and society (iri), Palisades, NY, United States of America; (3) CIFOR, Bogor, Indonesia.

The drought of 2005 was a “1 in 100 years” event in western Amazon resulting in fire damage to over 300,000 hectares of rainforest in the Brazilian state of Acre and 2010 another drought resulted in the isolation of entire communities as the Negro River, a major northwestern Amazon tributary, registered its lowest water level in over a century. The Amazon ecosystem is sensitive to repeated occurrence of droughts, which interferes with the forest’s natural ability to recover from stress and undermine climate change mitigation efforts to reduce CO2 emissions from deforestation and forest degradation. Whether this apparent increase in drought severity and frequency is related to natural low–frequency modes of climate variability, to anthropogenic influence on climate, or to a combination of both is explored here.

A modest negative trend in dry–season precipitation is observed in western Amazon over the period 1935–2012, which along with a multi–decadal pattern of reduced moisture transport from the tropical Atlantic was sufficient to enhance the severity and frequency. Most of the western Amazon dry–season precipitation decadal variability is attributable to decadal fluctuations of the north–south gradient (NSG) in Atlantic sea surface temperature (SST). The observed western Amazon and NSG decadal co–variability is well reproduced in Global Climate Models (GCMs) pre–industrial control (PIC) and historical (HIST) experiments that were part of the intergovernmental Panel on Climate Change assessment report (IPCC–AR5). This suggests that unforced or natural climate variability, characteristic of the PIC simulations, determines the nature of this coupling, as the results from HIST simulations (forced with greenhouse gases (GHG) and natural and anthropogenic aerosols) are comparable in magnitude and spatial distribution. Decadal fluctuation in the NSG also determines shifts in the probability of dry and wet events in western Amazon, as there is a 66% chance of 3 or more years of dry events per decade when NSG>0 compared to 19% when NSG<0. The NSG and PIC models each show an interdecadal variation in the probability of occurrence of dry and wet events as a function of the NSG decadal phase, suggesting there is great potential for decadal predictability based on CDR. Persistence of the NSG positive phase may lead to continuing above normal frequencies of western Amazon dry–season droughts.

Stochastic low-frequency variability in the eddying ocean: mid-latitude imprints, possible atmospheric impacts

T. Penduff (1) ; L. Terray (2) ; S. Leroux (1) ; G. Séradim (1) ; P. Barnier (1); J.M. Molines (1); L. Bessières (2)

(1) LGGE, MEOM, Grenoble Cedex 9, France; (2) CERFACS; CNRS, Sciences de l’Univers au CERFACS, URA1875, Toulouse, France.

Laminar Ocean General Circulation Models (2° to 1° resolution) used in recent climate projections are being progressively replaced by turbulent ocean models (about 1/4° resolution) in the perspective of the next CMIP exercise. Atmospheric–forced ocean experiments show that this resolution change impacts the consistency of simulations, but also allows the ocean to spontaneously generate a substantial variability up to interannual–to–multidecadal timescales. Consistently with previous idealized studies, the low–frequency intrinsic variability (LFIV) is negligible when mesoscale oceanic eddies are not explicitly resolved, and spontaneously emerges in the turbulent regime. This non–linearly driven oceanic LFIV has a stochastic character, and a marked signature on the upper ocean temperatures in mid–latitudes regions where air–sea fluxes are maximum in Nature. Seasonally–driven global eddying ocean simulations exhibit the strong, large–scale imprints of this stochastic LFIV on several climate–relevant oceanic indices: sea–surface height (SSH) and temperature (SST) in western boundary current systems and the Antarctic Circumpolar Current, Meridional Overturning Circulation (AMOC) throughout the Atlantic Ocean, etc. How these low–frequency intrinsic variability modes are impacted, and may or not be paced, by the interannually–varying atmosphere is an important question about climate uncertainty. OCEAN project aims at investigating these questions probabilistically through a 50–member ensemble of 1/4° global ocean/sea–ice 57–year hindcasts, driven by the same 1958–present atmospheric forcing. Present results demonstrate that initial state perturbations spontaneously grow, cascade toward long space and time scales and non–linearly saturate. The resulting ensemble spread describes the atmospherically–paced LFIV (for certainty), with marked imprints on oceanic variables at large space and time scales both at the surface (SST, SSH) and below (AMOC, mode/intermediate/deep water mass properties and depths, etc).
This ensemble experiment will provide the first probabilistic description of the global ocean state and evolution over the last decades, and a measure of the actual constraint exerted by the atmosphere on low-frequency ocean variability. The imprint of this stochastic LIFV on the upper–ocean thermal fields and AMOC will then provide insights into how this eddy–driven low-frequency oceanic “noise” might ultimately impact the atmosphere and ocean predictability in future coupled climate projections.

O-1117-04

Contribution of sulfate anthropogenic aerosols to the Euro-Mediterranean climate trends since 1980 using a regional coupled modelling approach

P. Nabat (1) ; S. Somot (1) ; M. Mallet (2) ; A. Sanchez-Lorenzo (3) ; M. Wild (4)

(1) Météo–France / CNRM–GAME, Toulouse, France; (2) Laboratoire d’Aérologie, Toulouse, France; (3) University of Girona, Department of physics, Girona, Spain; (4) ETH, Zurich, Institute for atmospheric and climate science, Zurich, Switzerland

Since the 1980s, sulfur emissions have considerably been reduced in industrialized countries, notably in Europe, thus leading to a decrease of sulfate aerosol concentration over the Euro–Mediterranean region. Meanwhile, an increase of incoming solar radiation exiting the Earth’s surface is observed, known as the brightening effect, has been observed over the same period but global and regional climate models still have trouble in reproducing the all-sky surface solar radiation trends and their consequences on climate.

In order to investigate the consequences of this aerosol trend on regional climate and its role in the observed changes during the last three decades, the presentation introduces an original approach, through the use of a fully coupled regional climate system model (CNRM–RCSM). This latter includes the different components of the regional climate system, namely the atmosphere (with ALADIN–Climate), the ocean (with NEMOMED8), the land surface (with ISBA) and the rivers (with TRIP). This approach enables us to take into account the high–frequency feedback of the sea surface temperature (SST) on the atmosphere, as well as the river–ocean–atmosphere feedback. Aerosols are included in ALADIN–Climate through monthly interannual climatologies, coming from a combination of satellite–derived and model–simulated products, and considered as the best possible relevant estimation of the atmospheric aerosol content for the five most relevant species (sea salt, desert dust, sulfates, black and organic carbon aerosols). Subsequently, the boundary forcing of the ERA–INTERIM reanalysis have been carried out over the period 1980–2012 with and without the trend in sulfate aerosols. The scattering of the incoming solar radiation by sulfate aerosols leads to important changes in the Euro–Mediterranean climate. Comparisons between both simulations and homogenized surface observations reveal that our model is able to reproduce the all-sky surface shortwave radiation trends only when the aerosol trend is included. This improvement is particularly visible in regions where aerosols have been strongly reduced (i.e., Central Europe, Po Valley). Aerosol changes explain 81% of the simulated brightening over the 1980–2012 period, while the direct effect has been found to be the main cause of the simulated brightening.

As a result of this brightening effect, when including the aerosol decrease, the surface temperature trend is higher and closer to homogenized surface observations, indicating that aerosols explain 23 ± 5 per cent of the observed warming between 1980 and 2012. The use of an atmosphere–ocean coupled model enables us to show that Mediterranean sea surface temperature changes are also better reproduced using the aerosol trend. Air–sea fluxes have consequently been modified by this evolution in the sulfate aerosol content, as well as river flow.

Overall, our results demonstrate the importance of changes in aerosol loads for the understanding of regional climate variability.

O-1117-05

Volcanic Forcing: new initiatives to establish its impacts on climates of the Southern Hemisphere

P. Harvey (1) ; S. Grab (1) ; F. Engelbrecht, (2)

(1) University of Witwatersrand, Geography, archaeology and environmental studies, Johannesburg, South Africa; (2) Centre for Scientific and Industrial Research, Natural resources and the environment, Pretoria, South Africa

In the northern hemisphere (NH), 1816 is well known as ‘the year without a summer’. But what happened in the southern hemisphere (SH) during that year? How did following other major tropical or SH volcanic eruptions impact SH climate and environment/society, and in particular, what could we have learned about the all-sky surface solar radiation changes during the last three decades, the present study introduces an original approach, through the use of a fully coupled regional climate system model (CNRM–RCSM). The latter includes the different components of the regional climate system, namely the atmosphere (with ALADIN–Climate), the ocean (with NEMOMED8), the land surface (with ISBA) and the rivers (with TRIP). This approach enables us to take into account the high–frequency feedback of the sea surface temperature (SST) on the atmosphere, as well as the river–ocean–atmosphere feedback. Aerosols are included in ALADIN–Climate through monthly interannual climatologies, coming from a combination of satellite–derived and model–simulated products, and considered as the best possible relevant estimation of the atmospheric aerosol content for the five most relevant species (sea salt, desert dust, sulfates, black and organic carbon aerosols). Subsequently, the boundary forcing of the ERA–INTERIM reanalysis have been carried out over the period 1980–2012 with and without the trend in sulfate aerosols. The scattering of the incoming solar radiation by sulfate aerosols leads to important changes in the Euro–Mediterranean climate. Comparisons between both simulations and homogenized surface observations reveal that our model is able to reproduce the all-sky surface shortwave radiation trends only when the aerosol trend is included. This improvement is particularly visible in regions where aerosols have been strongly reduced (i.e., Central Europe, Po Valley). Aerosol changes explain 81% of the simulated brightening over the 1980–2012 period, while the direct effect has been found to be the main cause of the simulated brightening.

As a result of this brightening effect, when including the aerosol decrease, the surface temperature trend is higher and closer to homogenized surface observations, indicating that aerosols explain 23 ± 5 per cent of the observed warming between 1980 and 2012. The use of an atmosphere–ocean coupled model enables us to show that Mediterranean sea surface temperature changes are also better reproduced using the aerosol trend. Air–sea fluxes have consequently been modified by this evolution in the sulfate aerosol content, as well as river flow.

Overall, our results demonstrate the importance of changes in aerosol loads for the understanding of regional climate variability.

Given the scarcity of SH instrumental records covering the Tambora and other major historical period volcanic events, little is known about their impact in southerly latitudes. Here we triangulate evidence from a variety of proxies including historical documentary sources, and tree ring and speleothem data, to demonstrate that major tropical or SH volcanic eruptions are usually followed by extreme climate events across much of the SH. For instance, in southern Africa, such events may be followed by exceptionally hot summers and severe winters (with unusually early and/or late frosts and heavy snowfall events) (Grab and Nash, 2010). Whilst this temporally mirrors austral winters and summers in the NH (which are warmer and cooler respectively), the cooling anomalies are seasonally reversed between the hemispheres. In addition, data thus far suggest that one to two years following such a major eruption has [have] a very high probability of experiencing very wet [floods] or very dry [drought] conditions, but that the relationship is not linear owing to other climate drivers such as ENSO cycles. This work is ongoing and seeks further evidence to substantiate these new findings.

Finally, we present our current and future aims to model the climatic impacts (all major climate parameters) of major volcanic eruptions over the past 20 years using two different parameterizations and spatial scales in the SH using the Variable–Resolution Earth System Model (VRESM) and its atmospheric component the Conformal Cubic Atmospheric Model (CCaM) (see Engelbrecht et al., 2011). The models will be integrated to simulate volcanic eruptions ranging in size from Toba to Pinatubo (or smaller), and will test the associations between geographic location (longitude/latitude) and event magnitude to establish spatial, temporal and type/magnitude of climatic impacts in the SH.
P-1117-01
Calibration and Validation of Summer Monsoon Rainfall over Bangladesh Using PRECIS Model
MN. Ahasan (1)
(1) SAARC Meteorological Research Centre (SMRC), Synoptic Division, Dhaka, Bangladesh

A regional climate model named PRECIS is employed in generating rainfall scenarios for SAARC region. PRECIS generated rainfall scenario is calibrated with ground-based observed rainfall during 1961–1990 in Bangladesh. Through calibration regression coefficients such as slope and constant are obtained at 27 observational sites over Bangladesh. The regression coefficients are utilized in validation of PRECIS generated rainfall during 2000 to 2006. Better performance of PRECIS through validation encourages applying it in rainfall forecasting for Bangladesh. In this work rainfall forecast for Bangladesh is performed experimentally for 2009. The monsoon rainfall is projected surplus 0.29 mm/day or 2.03% in 2009 and it will be surplus 0.44 mm/day or 14.02% in post-monsoon. It will deficit 0.11 mm/day (2.08%) and 0.01 mm/day (1.44%) in pre-monsoon and dry season respectively. Through the analysis of monsoon rainfall in Bangladesh this work discloses that PRECIS simulated rainfall is not directly useful in application purposes. Without calibration with ground-truth data model outputs are very risky in providing long-term rainfall prediction. However, it is one of the best available models at present. This work shows the importance of rainfall forecasting. The monsoon forecasting approach using downscaling of regional climate model outputs is very new in Bangladesh and also in SAARC region. This prejudices result suggests extending the work for other SAARC countries in a consecutive research project. Model run with other ensembles and with high horizontal resolution are also under consideration with the improvement of computational facilities in the Centre. After completion of the calibration and validation of PRECIS for SAARC region, the projected rainfall is supposed to be posted through SMRC website (www.saarc-smrc.org) which is now available only for Bangladesh. Completion of such type of job is really necessary for SAARC region where SMRC can play important role as a regional meteorological research centre.

P-1117-02
Crops response to climate variability and societal implications on rural dwellers of Nigeria
S. Ayanlade (1)
(1) Obafemi Awolowo University, Ile-Ife, Nigeria, Dept. of Geography, Ile-Ife, Osun, France

This study examines impacts of climate variability on the yield of eight major crops in the guinea ecological of Nigeria, using both quantitative and qualitative methods. The Guinea ecological zone represents a rich agricultural area for Nigeria, sometime call ‘the food basket zone’. This study focused on the role of climate variability in the yield of such crops. Majority of these studies were based on assessment of two to four crops. Thus, the present study apply GIS techniques to examine the climate variability and its implications on the eight crops (Cassava, yam, Maize, sorghum, Groundnut, Cowpea, Cocoyam and Melon), majorly cultivated in the area. Rainfall, temperature and the crops yield dataset from 1982 to 2012 were used in the analysis. A year is divided into two growing seasons on the basis of different cropping season. The long growing season (April–June) and late growing season (July–October) with regard to seasonal differences and the crops yields. The results show that during the past decades the yields of these crops were associated with climate variability, which vary differently in the year with high rainfall than the year with low rainfall. The study found out that the crops yield have been dominated by reduction in the number of rain days during the middle of the rainy season and there is evidence of a significant change in the crop yield as climate varied. The study concluded by recommending the need to encourage rain fed agriculture and agricultural research to improve crop yields.

P-1117-03
Diatoms evidence for past two centuries major changes in seasonal sea surface conditions prior the instrumental period in the southern Gulf of California
L. Barbara (1); S. Schmidt (2); J. Urrutia Fucugauchi (1); L. Perez Cruz (1)
(1) Universidad Nacional Autónoma de Mexico, Instituto de geofisica, Mexico D.F, Mexico; (2) CNRS, UMR 5805 EPOC, Université Bordeaux , Pessac, France

Studies on laminated marine sediments have enabled to exploit annual to subseasonal information of oceanic and climatic conditions of the past, and particularly in the Gulf of California where there are excellent laminated records, underling anoxic basins. These studies, however, are based on resin–embedded thin sections and present only qualitative snapshots of the past environments. Any of them have compared high resolution records with instrumental data, in order to reconstruct the environmental conditions and document the variability on interannual to decadal timescales beyond the instrumental period.

Here, we describe environmental conditions in the eastern part of Carmen Basin in the southern Gulf of California, over the past two centuries using diatom counts in the DIPALV–C33 marine sediment box core. Diatom census counts show progressive changes since AD 1850, marked by persistent warm stratified and nutrient limited water conditions on the Gulf of California floor. In this study, high-resolution instrumental data provide evidence for reduced seasonal upwelling during the last century and limiting primary productivity, concurrent with increase of storm/hurricane frequency. Despite the smaller land area, regional wind fields in relation to the position and intensity of the atmospheric low and high–pressure trough around the Gulf of California, however, both ENSO and PDO variability patterns in the last century cannot explain the regional trend observed in this study, probably due to the effect of local processes on the response of our biological proxies.

P-1117-04
Mechanisms relating the MJO to intra-seasonal variability of the surface climate in the Americas
EH. Berbery (1); M. Natoli (2)
(1) University of Maryland, Earth System Science Interdisciplinary Center/CiCs-MD, College Park, Maryland, United States of America; (2) University of Maryland, Earth system science interdisciplinary center, College Park, Maryland, United States of America

This study uses the NCEP's Climate Forecast System Reanalysis (CFSR) to revisit the dynamical mechanisms associated with the Madden–Julian Oscillation (MJO) that affect the surface climate over the Americas. During the boreal cold season, North America sees a notable eastward propagation in temperature anomalies through the MJO evolution. Despite the smaller land area, temperature effects in South America during the austral cold season appear clearer than in North America and more appropriately connected to MJO convection. This is especially true over subtropical portions of the continent. These structures are related to the MJO enhanced tropical convection that can induce anomalous upper-tropospheric cyclonic circulation on the leading edge of the MJO enhanced convection and anomalous anticyclonic circulations trailing the convection. During each hemisphere’s winter season, and connected with these patterns, enhanced direct circulations favor changes in the subtropical and polar jet streams. Intra-seasonal changes in the divergent circulation in upper levels modulate the Rossby Wave Source centers around 30–45° latitude and the propagation of Rossby waves, as noted in the wave activity fluxes, into the extratropics inducing near-surface
temperature and precipitation anomalies.

During the corresponding summer seasons, the diagnostics show that precipitation patterns are more directly connected to the convection anomalies rather than the climate parameters. The relationship between precipitation and monsoon systems changes when the large scale upper tropospheric divergence associated with the MJO convection passes over the western hemisphere. Similarly, suppressed precipitation in these regions is observed when the large scale upper tropospheric convergence passes over the continents.

P-1117-05
Climate Change Studies over Western-ghat Region using Remote Sensing & GIS Modelling

N. Bhat (1); KC. Gouda (2)

(1) Shri Madhwa Vadiraja Institute of Technology and Management, computer sc & engg, Udupi, Karnataka, India; (2) CSIR CMMACS, CEMP, BANGALORE KARNATAKA, India

Western ghat region is one of the major mountain system in the Indian subcontinent, extending in the western part of Indian from Kerala in South till Maharashtra in north and the total area is about 160,000 Sq. km. The western ghat is the most important from different point of view starting from the flora and fauna to medical plant to the rich region of river systems and the orography is most important for its role in the Rainfall during Monsoon and other seasons. In the study high resolution data from different sources like MODIS, TRMM, IRS and the multi-source observations from reanalysis products like NCEP, ERA–40, JMA and the high resolution observations like IMD are being used to study the climate change over the mountain region region is developed and presented in a very user friendly way which can be easily used by the users of different sectors for the better understanding of the climate change.

P-1117-06
Temperature impact on Non-Communicable Diseases in Africa – a Blind Spot in Research

A. Bunker (1); E. Diboulo, (2); A. Sié, (3); R. Sauerborn (4)

(1) University of Heidelberg, Network Ageing Research and Institute of Public Health, Heidelberg, Germany; (2) Swiss Tropical and Public Health Institute, Epidemiology and Biostatistics, Basel, Switzerland; (3) Centre de Recherche en Sante de Nouna, Nouna, Burkina Faso; (4) Heidelberg University, Institute of public health, Heidelberg, Germany

The mean temperature in northwest rural Burkina Faso, in the Nouna Health and Demographic Surveillance System (HDSS) region, is projected to increase under different climate change scenarios by the end of the 21st Century[1]. The Nouna HDSS consists of approximately 100,000 people, and is one of several sites in the Demographic Evaluation of Populations and Their Health (INDEPTH) sites that collect health and demographic data across populations in low- and middle income countries. As life expectancy increases in Burkina Faso people will live longer with chronic and degenerative diseases, non-communicable disease will play a greater role in contributing to the burden of disease. This study assesses the impact on 18 years of temperature exposure on non-communicable disease years of life lost, an indicator of premature mortality, in the Nouna HDSS population.

P-1117-07
Farmers’ perceptions of climatic trend in Allada plateau in southern Benin

A. Cayossi Ulrich (1) ; A. Abel (2) ; G. Hervé, (3) ; EK. Agbossou (4) ; V. Pierre, (1) ; C. Baron (3)

(1) université d’Abomey–Calavi, COTONOU, Benin; (2) Université d’Abomey–Calavi, Graduate research program on climate change and water resources, Abomey- Calavi, Benin; (3) CIRAD, Montpellier, France; (4) UNIVERSITY OF ABOEMY–CALAVI, Faculty of agronomic sciences, Abomey-Calavi, Benin

Although several studies show an increase in agricultural production in West Africa in connection with the improvement in rainfall, farmers perceive otherwise; This study highlights the differences between farmers’ perceptions of changes in precipitation and their impacts on agricultural production and scientific observations in the Guinea region where two rainy seasons coexist. For the purpose, it compared precipitation data (from 1951 to 2010) and potential yields of corn (from 1970 to 2010), simulated by SARRA-H model, to farmers’ perceptions of changes in precipitation collected from 201 farm managers spread over 67 villages in Southern Benin. The study clearly shows that farmers do not make any distinctions between the long rainy season and short rainy season in terms of changes in rainfall and agricultural impacts. On the contrary, climate change results, and agronomic simulations reveal that the long rainy season and short one are not affected in the same way by atmospheric forcing. Consequently, these two rainy seasons have opposite agronomic trends. Since 1970, the short rainy season rainfall recorded a sharp drop in potential crop yields. Conversely, since the late 1980s, the short rainy season season rainfall recorded a surge which causes a sharp increase in agricultural yields. This pessimistic perceptions of farmers on the evolution of rainfall in both rainy seasons influences their choice of management of the farming calendar of the short rainy season, worsening food insecurity in the study area.

P-1117-08
On the characteristics of climate change in Scandinavia and its association with the Northern Atlantic Oscillation (NAO) and sea ice

Y. Chen (1); S. Stefan (1)

(1) Uni Research Climate, Bjørknes Centre for Climate Research, Climate Data Service, Bergen, Norway

We analyzed some characteristics of climate change over Scandinavia using CRU data (1901–2012), and both temperature and precipitation exhibit well-documented poleward trends. However, spatial variability of these trends is large with some areas showing high significance (northern Norway and Sweden) and others none at all (central Finland). The scenarios simulated by NorESM and ECHAM6 models exhibit continued warming and increased rainfall in the 21st century over Scandinavia, given the
climate change in Nepal is more pronounced compared to other countries or regions. Centrally located in the Himalayan range, its average annual increase in temperature is 0.06 °C since late 1970s while the precipitation pattern is quite erratic. Even though Nepal’s climate is double in the high mountains than that in its foothills or lowland Tarai conjoint to Gagnet plain. The future projection of the trend is deemed necessary; however, available meteorological data are inadequate. Taking advantage of Nepal’s rich tree diversity distributed in diverse topography of varied aspect and high elevation range, we carried out dendro-climatological study in 15 different sites of Nepal Himalaya from east to west that included eight protected areas of the high mountains. The objective of the study was to reconstruct the past climate of Nepal Himalaya. For the purpose, over 1400 treering samples were collected from alpine forest species such as Abies spectabilis, Abies pindrow, Betula utilis, Juniperus recurva, Larix griffithii, Picea smithiana, Tsuga dumosa were analyzed following standard dendrochronological techniques. Positive correlation was observed among the chronologies of different species within and between different sites indicating some common climatic factors limiting the growth of these trees, and this gave us the basis for climate reconstruction.

Response function analysis revealed that pre-monsoon temperature (March-May) had an indirect relationship with growth of most of the species while a significant relation with precipitation of pre-monsoon to monsoon (March–July) depended also on the site condition. In some treeline sites, winter climate had significant influence for the growth in subsequent growing period in most of some of these species. The seasonal correlation analysis with climate data for 1899–2012 revealed a significant indirect relationship between the ring width and spring temperature ($r = -0.56$) and positive correlation with spring precipitation ($r > 0.50$). The temporal stability of correlation model was tested by dividing the annual time series data into two equal halves as early and late period and found significant with correlation of $r = 0.51$ and $-0.62$, respectively. The stability of the model led to the reconstruction of March–May average temperature for the past 373 years (AD 1640 to 2012).

We used a simple linear regression model for temperature reconstruction. The validation of the reconstruction model was assessed through statistical reduction of error (RE) and coefficient of efficiency (CE) using split sample procedure i.e., by dividing the calibration period into two equal sub-periods. The model was further validated through spatial correlation with gridded temperature data. This temperature reconstruction identified several periods of warming and cooling, however, it did not show the significant pattern of cooling during the Little Ice Age except few cold episodes. Similarly the reconstructed precipitation for 311 years (AD 1702–2013) showed several high events and low events of precipitation. High precipitation events were seen in AD 1720, 1740, 1751–1765, 1819–1830, 1882–1888 and 1912–1922. On the other hand low precipitation event was in AD 1741–1720, 1741–1750, 1780–1788, 1800–1818 and 1922–1975.

The correlation of spring temperature with Sea Surface Temperature (SST) index of different region of the equatorial Pacific viz., NINO1.2, NINO3, NINO3.4 and NINO4 and extended ENSO index such as Niño4 was carried out. It presented a significant negative correlations with monsoon and post monsoons seasons. These negative correlations suggest that warm (cool) spring season over the western Nepal Himalaya is associated with cold (warm) SSTs in the following seasons. Furthermore spatial correlation of spring temperature with Sea Surface Temperature showed similar negative correlation in the equatorial belt of the Pacific Ocean. The relationship showed the climate of western Nepal has linkages with spatio-temporal climatic variability at a global scale.
P-1117-12
Temperature effects of the large volcanic eruption events during the past 100 years over China
Z. Hao (1); D. Sun (1); J. Zheng (1)
(1) Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing, China

Based on the meteorological temperature data and the records of volcano events, the temporal and spatial temperature characteristics after the different types of large volcanoes which were classified by the geographic latitudes were identified in China five climatic regions, and the effects of the large volcanic events on regional temperature were analyzed. The results showed that there were significant differences between the temperature variation during winter years and the summer years after different large volcanic eruptions. Northeast region was warmer in winter year after the large volcanic eruptions and at the same time, the observed temperature decrease, northeast and northwest regions which were sensitive to climatic change was cooler. In addition, there was an obvious secondary cooling process during the winter year, the change of cooling even more obvious than the first cooling process. At the same time, the impact of large volcanic eruptions was different in five climate regions, and the relationship of the variation of sea surface temperature variability after large volcanic eruptions at equatorial and high latitudes, but this variation related to longitude after volcanic eruptions at low and middle latitudes.

P-1117-13
A Study of Multi-decadal Global Sea Surface Temperature Variability Based on CMIP5 and Reanalysis Data
S. Henson, (1) ; C. Beaulieu, (1) ; L. Zhang, (1)
(1) University of Southampton, Ocean and Earth Science, Southampton, United Kingdom

The analysis of long-term changes in the distribution (mean, variance and extremes) of climate variables is essential for a full understanding of climate change and its impacts. The majority of climate change studies have focused on changes in the mean climate, therefore understanding the changes in the extremes and variability of climate variables may impact biological and food systems. Observed and projected long-term changes in climate variability still lack investigation.

Noticing this, we explore the patterns of sea surface temperature variability by looking at the observed sea surface temperature data record from 1854 to 2014. We investigate the global yearly and monthly sea surface temperature variability changes. For example, annual mean sea surface temperature and intra-annual variability (measured by the standard deviation and range). We also investigate the global and regional decadal changes in sea surface temperature variability, for example, using normalized probability density functions for different periods of anomalies in the data set.

In addition to the analysis of observational data, we assess how sea surface temperature variability may change in the future using model projections. We analyse the model projections by targeting the RCP8.5 (business-as-usual emission scenario) and the RCP4.5 (mitigation scenario) from the Coupled Model Intercomparison Project Phase 5 (CMIP5). This allows us to verify whether mitigation has an impact on projected changes in climate variability.

Comprehending the changes in climate variability is important for our society. Revealing the potential patterns of sea surface temperature variability can help us better understand the climate variability.

P-1117-14
Correlation between Polar motion and climate variables during 1962-2013
M. Huang (1)
(1) Institute of Geographical Sciences and Nature Resources Research, Chinese Academy of Sciences, Beijing, China

Polar motion is a significant Earth orientation parameter, but our understanding of its relation to climate forcing remains highly uncertain. In this study, the relationships between the polar motion and climate and climate variability are examined. High correlations are found between the excitation and annual mean climate variables, such as air temperature, atmospheric pressure, zonal wind at various atmospheric pressure levels, except for 1000 hPa. High correlation coefficients between the excitation and climate variables are found for the regions of the Arctic, Antarctic and Indian Ocean, with the center values exceeding 0.7. Two distinct excitation time series are detected and the accompanied changes of climate variables are also studied. Since the polar motion can be accurately measured by satellite, the accurately determined polar motion excitation time series becomes an indicator for monitoring and understanding the global climate change.

P-1117-15
Climate change vulnerability of fishery-dependent coastal communities in Bangladesh
N. Islam (1); MM. Islam (1)
(1) Sylhet Agricultural University, Department of Coastal and Marine Fisheries, Sylhet, Bangladesh

Being situated in a deltaic geographic setting, Bangladesh is considered as one of the most climate-vulnerable countries on the planet. The country is highly dependent on climate change related events such as cyclones, rising tidal floods, erosion and inundation, saline water intrusion which is further compounded by degraded natural resources bases. In contrast to other large coastal communities, very few research have conducted in Bangladesh on vulnerability of fishery-based livelihoods to climate change impacts. Based on a fieldwork with fishing communities in rural area of south-west coastal Bangladesh, the present study assessed vulnerability of fishery-based livelihoods to climatic change and variability. Bottom up research approach was adopted in the study and participants’ information was collected through 70 individual interviews and 5 focus group discussions. The result revealed multi-faceted vulnerabilities across different scales that impinge on the livelihoods of already resources-poor fishers’ community in coastal Bangladesh. In line with global evidences, the level of vulnerabilities differs among the communities and across households within a community. Being dependent on climate sensitivity, fishers’ resources, fishers’ vulnerability further depend on their level of exposure, and adaptive capacity. For instance, fishers’ level of exposure varied depending on areas of their fishing. Fishers with limited assets usually do not fish in case of disaster as they are less exposed to extreme events, however when disaster struck in their living places they are more vulnerable due to limited adaptive capacity. The case is reverse in case of better off fishers. They go for sea fishing thus more exposed to extreme events; however better adaptive capacity due to strong financial capabilities. In both cases, fishers reported an increase of climate change-induced extreme events such as storm surge, strong wind, higher wave and stronger current during fishing operation that often cause loss in physical capitals and subsequent financial hardship. Low earning fishers’ lives is also common as a deadly consequence during fishing in sea. A number of internal and external factors regulate adaptive capacity of fishing communities in the study areas. Adaptive capacity of fishers often differs due to various factors such as inappropriate fishing vessels, lack of modern fishing appliances, inadequate and poor infrastructure of cyclone shelter, complexities and non-availability of scheduled credit during crises period, exploiting relationship between fishers and fish entrepreneur (money lender) lack of alternatives livelihood opportunity etc. To illustrate, with absence of state loan facility, fishers often have to take loan from moneylender at interest rate that create long term debt bondage with fish entrepreneur that weaken fishers’ adaptive capacity. A number of external factors such as lack of security during deep sea fishing, also make fishers’ lives more vulnerable by influencing their financial and social capabilities. For instance, increased risk of piracy in the bay causes financial loss of fishers in the form of ransom pay, bodily harm including death as well as loss of fishing gears and craft. In the above-mentioned, the present study submits
that to make climate resilient fishing communities in Bangladesh, it is important to address no-climate related factors, along with climate change related factors for a more holistic adaptation policy.

**P-1117-16**

**Assessment of Regional Climate Models over Côte d'Ivoire and Analysis of Future Projections over West Africa**

K. Kouadio (1); A. Konare (2); A. Diawara (3); K. Dje (4); VO. Ajayi (5); A. Diedhiou (6)

(1) LAPA - MR, Université Félix Houphouët-Boigny; WASCAL, Federal University of Technology Akure, Abidjan, Ivory Coast; (2) Universite Felix Houphouet Boigny, Cocody, UFR ssmt, Abidjan, Ivory Coast; (3) University Felix Houphouet Boigny – Cocody Abidjan, Physic, Abidjan, Ivory Coast; (4) Société d’exploitation et développement Aéroportuaire et Météorologique, Abidjan, Ivory Coast; (5) WASCAL, GRP – WACS, Federal University of Technology Akure, Akure, Nigeria; (6) Republic of (6) Institute of Research for Development (IRD), LTHE – University Grenoble Alpes, Grenoble Cedex 9, France

The ability of six Regional Climate Models (RCMs) used in AMMA–ENSEMBLES project is assessed over six meteorological stations in Côte d’Ivoire. The ensemble mean of the models is also used for the prediction of climate change over West Africa. The data focused on two periods: the period 1995–2005, the present-day simulations, is used to evaluate the skills of the models over the country and the years 2010–2030, for assessment of the future climate change scenario used. The results show that the skills of the models vary from one station to another and from one season to another. None of the models considered, presents an excellent performance over the data. In general, the ensemble mean of all the models presents better results when compared with the observation. These results suggest that the choice of any model for study over the country is dependent on the focus of interest: intensity and variability of the rain and also on area of interest. The projection for 2020–2040, future climate change over West Africa shows that the Sahel exhibits a tendency to be drier while wetter Guinean coast is observed.

**P-1117-17**

**Recent Observations and Experiences of Glaciers response to Intrinsic Climatic Variability: the Himalayan Inquest**

P. Kumar (1); M. Sharma (2)

(1) Jawaharlal Nehru University, Centre for the Study of Regional Development, Delhi, India; (2) Jawaharlal Nehru University, Centre of the study of regional development, Delhi, India

The earth’s climate has undergone a many phases of both long and short term fluctuations in the past; more significantly in the Holocene. However, the recent climatic fluctuations has become a bone of contention among scientist for as to what causes these changes; to be precise, through the human actions. Therefore, the understanding of the complex interplay of natural and human actions needs to be precisely quantified for a better understanding and impact thereof. The Himalayan environ, with one of the sensitive parameters in the form of ice and glaciers, is proving to be an indispensable laboratory for evaluating and understanding climate variability through these fluctuations in space over a longer temporal scale. Many climate scientists agree on the warming trend of climate past few decades. There are no concrete studies on regional climatic variability especially at the higher altitudes. As a layman we understand that climate changes regionally, based on latitude, altitude, aspect, and land-cover and vegetation. Lack of climatic data in the Himalayan region limits us to assess just this sensitive key in the form of glaciers on a longer time scale, given the understating that response time is very large. Now the question arises, how much do we know about the changing climate in the Himalayas? We present here the land surface temperature (LST, MODIS) data of the higher altitudes and behavior of glaciers for past one decade in the Himalaya and an assessment among the point source data and grid based data analyzed. Point source data of Bhojbhas has taken from the Automatic Weather Station (AWS), Snow and Avalanche Study Establishment (SASE). The grid source data are satellite based Land Surface Temperature (LST) temperature data obtained from Moderate Resolution Imaging Spectroradiometer (MODIS). A strong relationship emerges between satellite based and ground based data, a general indicator of change, especially at high altitude and a complex climate system like the Himalaya. The analysis of data are provides a very strong and positive correlation (0.887), which means 89 percent of SASE data, is explained by the MODIS data. The coefficient of determination is 0.7870; therefore, about 78.7% of the variation in the SASE data is explained by MODIS data. The root mean square error (standard deviation of regression) is 2.4569, which is very close also provides a better fit. All the stations values are represented on the simple line; and a simple linear trend lines have been drawn on temporal framework. The daily data trend of the station data show significant results in a simple regression line (2000–2013). But the yearly trend line data shows variability as; Harsil (0.241); Bhojbhas (0.158); Kalapani (0.208), Rudugaira (0.104), Raktavarn (0.0102) and Chaturangi (0.134) which is highly significant. There is a high variability in the elements but is not reflected as such in the study area during the last thirteen years. Trend lines show downward dip, meaning that there has been, without any doubt, temperature has dropped during 2000–2013. It is but true that temperature is a highly variable component in the high altitudes and may vary on the hourly and daily basis. But the thirteen years of data for five different stations portray a declining trend. Behavior of minimum and maximum temperature variability is not similar, each at varied nature in different stations. Given that we have not been able to conclude precise results for the same duration for these stations, it is highly speculative to assume that declining trend line may, on a longer temporal scale, like the Himalayan glacier beyond the limit of imagination. Indeed the last 100 years glacier responses with differential rate due to their different geomorphological, geographical, climatic conditions and especially the region of elements. Some types of results are observed in Western Himalaya, particularly in case of Gangotri glacier, which is retreating with an alarming rate until. Although since 2001 rate of retreat has been slow down since 2001, but the variation between 1994 and 2014 are no significant changes in glacier snout. Interestingly terrestrial records are showing that two of its tributary glaciers as Raktavarn and Chaturangi glacier are showing positive change in their mass and terminus position since 1994. It propounds the complexity of glacier responses even within same geographical and climatic conditions, which means behavior of glacier is identical in nature, with self strength of mind.

**P-1117-18**

**Simulations of Future Climatological Conditions in Central Asia CORDEX Region 8 by Using RegCM4.3.5**

L. Kurnaz (1); MT. Turp (2); T. Ozturk, (3); M. Turkes (4)

(1) Bogazici, Center for climate change and policy studies and department of physics, Istanbul, Turkey; (2) Bogazici, Center of environmental sciences, Istanbul, Turkey; (3) Isik University, Physics department, Istanbul, Turkey; (4) Bogazici, Center for climate change and policy studies, Istanbul, Turkey

In this work, projected future changes in mean surface air temperature and precipitation climatology, inter-annual and seasonal variability and climatic aridity/ humidity conditions for the period 2010–2100 over the latest Central Asia region is assessed. The data (from 1970 to 2000) were simulated based on the RCP4.5 and RCP8.5 emission scenarios. Regional Climate Model (RegCM4.3.5) of the International Centre for Theoretical Physics (ICTP) was used for projections of future and present climate conditions. HighGEM2 global climate model of the Met Office Hadley Centre and MPI–ESM–MR global climate model of the Max Planck Institute for Meteorology were downscaled to the CORDEX Region 8. We investigated the seasonal time-scale performance of RegCM4.3.5 in reproducing observed climatology over the domain of Central Asia by using 2 different global climate model outputs. For the winter season, the regional model predicts relatively high warming in the warm season and northern part of the domain at cold season with a decrease in precipitation almost all part of the domain. The results of our study show that surface temperatures in the region will increase from 1 °C up to
more than 7 °C on average according to the emission scenarios during the period 2010–2100 with respect to the past period 1970–2000. Therefore, the projected warming and decrease in precipitation and also resultant or associated increased aridity and more frequent and severe drought events very likely adversely affect the ecological and socio-economic systems of this region, which is already characterised with mostly arid and semi-arid climate and ecosystems.

P-1117-19

Spring temperatures in the far-western Nepal Himalaya since AD 1640 reconstructed from Picea smithiana tree-ring widths

U. Kuwar Thapa (1) ; SK. Shah, (2) ; DR. Bhuju, (3) ; NP. Gaire (4) ; S. St. George (1)

(1) University of Minnesota, Geography, Environment and Society, Minneapolis, Minnesota, United States of America; (2) Birbal Sahni Institute of Paleobotany, Lucknow, India; (3) Central Department of Environmental Science, Tribhuvan University, Kathmandu, Nepal; (4) Nepal Academy of Science and Technology, Faculty of Science, Lalitpur, Nepal

The Nepal Himalaya has heated rapidly over the last four decades (more than twice the mean global rate), with this warming being even more pronounced in higher elevations. Unfortunately, because climate records in most of the country do not go back prior to AD 1980, these short records make it more difficult to gauge the rate and (potential causes) of recent changes or enact long-term plans for resource management in the Nepal Himalaya under changing climate.

We conducted dendroclimatic study in order to extend the temperature record in western Nepal Himalaya beyond the instrumental period. For this, we developed a new, 422-year long tree-ring width chronology (spanning AD 1591–2012) from Picea smithiana (Wall.) Boiss in Khaptad National Park, which is located in the far-western Nepal. This climate record indicates a significant indirect relationship with spring temperature (March–May) and lead to the reconstruction of March–May average temperature for the past 373 years (AD 1640–2012). The construction was done on validation statistics commonly used in tree-ring based climate reconstruction. Furthermore, it was validated through spatial correlation with gridded temperature data. This temperature reconstruction identified several periods of warming and cooling, The reconstruction did not show the significant pattern of cooling during the Little Ice Age but there were few cold episodes recorded. However, the reconstructed temperature revealed the recent warming for last three decades as recorded in the stations. Wavelet analysis revealed high frequency variability (2–7 years) of spring temperature in western Nepal Himalaya for last four centuries, which can be linked to global climate system, El–Nino Southern Oscillation (ENSO). Significant negative correlations were found between the spring temperature in western Nepal and temperatures of monsoon and post monsoon seasons over the equatorial Pacific Ocean. This showed western Nepal Himalaya has linkages with climatic variability in a global scale.

This multi–centennial reconstruction of temperature in western Nepal Himalaya would serve as a basis for Ministry of Environment, Science and Technology to develop climate change adaptation strategies, including the National Adaptation Program of Actions and Local Adaptation Plans of Action. Future climate modeling shall also possible with this long available estimated temperature record for west Nepal.

P-1117-20

Drought monitoring with root zone soil moisture derived from ASCAT satellite data over the East Asian region

JH. Lee (1) ; J. Im (1)

(1) UNIST, Urban and env engineering, Ulsan, Republic of Korea

Several studies showed that semi–arid regions of Asia are vulnerable to climate change induced drought (Alimullah Miyan , 2014). While drought has often occurred over the East Asia, we have little understanding of drought at a large scale in that region. Accordingly, there is a need to establish an appropriate drought monitoring and prediction system. There are different types of drought such as agricultural drought or hydrological drought (Rhee et al., 2010). The factors that influence drought are interconnected land–atmosphere interactions. One of the major factors is soil moisture, which can be effectively used to monitor agricultural drought. The surface soil moisture information from ASCAT satellite data is employed to provide root zone soil moisture for drought monitoring. This approach suggests several merits, when compared to the MODIS Vegetation–Index–based indicators or precipitation–based indices often applied to drought monitoring. First, it is difficult to characterize the dynamics of soil dryness with the vegetation indices such as leaf–area–index (LAI) or normalized difference vegetation index (NDVI), as some vegetation species well grow up in dry soils. Secondly, it is difficult to monitor the deep soil that is actually important for predicting the agricultural productivity solely with the precipitation indices, because it is still unknown whether precipitation will infiltrate into the soils, evaporate/transpose, or run off.

For these reasons, root zone soil moisture is considered a key indicator for agricultural drought monitoring due to its direct relationship with agricultural productivity and its climatic implication over the land (Lee, 2014). In this study, we use an exponential filter to infer root zone soil moisture from the satellite–retrieved soil moisture. Wavelet analysis revealed significant indirect relationship with spring temperature (March–May) and lead to the reconstruction of March–May average temperature for the past 373 years (AD 1640–2012). The construction was done on validation statistics commonly used in tree-ring based climate reconstruction. Furthermore, it was validated through spatial correlation with gridded temperature data.
solar cycles (Cs) had the long-lasting solar wind high speed streams occurred frequently and were the primary contributors to the recurrent Dst variations. They also had effects on cosmic rays variations. We show that during the 11-year solar cycles 20–23, the IMF B, global temperature and Dst variations were correlated with the cosmic ray count rate. We demonstrate that the detrended annual means of global surface air temperature in 1965–2012 show the maxima during CRs and Dst index minima. It proves that the CRs in essential daily high speed stream occurred frequently and were the primary contributors to the recurrent Dst variations and had effects on cosmic rays variations. We have studied conditions in interplanetary space, which can have an influence on galactic cosmic rays (CRs) and climate change. We show that long-term cosmic ray count rate variations in Cs 20–23 were modulated by solar activity and by the B of IMF which are correlated with Dst variations. On the long-term scale, the correlation B of IMF and Dst index is much higher than the correlation between solar spot numbers.

P-1117-23
Local climate assessments in data scarce mountain areas; for example Kullu district, Himachal Pradesh, India

A. Linsbauer (1); N. Salzmann (1); M. Rohrer (2)
(1) University of Fribourg, Department of Geosciences, Fribourg, Switzerland; (2) Meteodat GmbH, Zurich, Switzerland

High-mountain regions like the Himalayas and their adjacent downstream areas are often highly affected by climatic changes, climate variability and/or related extremes. As a result of cascading effects of rising air temperatures, melting glaciers, thawing permafrost – as well as anthropogenic water usage or changes in forest and agro-biodiversity – vulnerability of people's livelihood has broaden and increased. However, climate impacts assessments on physical and societal systems are often limited due to the scarcity of reliable long-term observations in remote high mountain regions, which additionally also hampers robustness of future projections. Since livelihoods in remote high-mountain regions are particularly vulnerable to climate related impacts, and have typically only low adaptive capacities, studies assessing climate variability pattern of the past and for the future are an important basis for sound impact assessments, and as such for preparing and planning adequate adaptation measures. Key for such studies and measures are climatic baselines.

Within the Indian Himalayas Climate Adaptation Programme (ICHAP) integrated vulnerability and hazard and risk assessments are on the way for the Kullu district in Himachal Pradesh, India, for the sake of supporting adaptation strategies. The present work aims to provide an approach and according results for climatological baseline generation for regions without respective observations available or accessible. Here, we use observational gridded data sets (CRU, CPCP, TRMM, IMD, Berkeley) and Reanalyses (ERA-1, MERRA, NCEP/NCAR-R1, CR20) to provide spatially and temporally continuous data. For the grid boxes covering the area of interest, the time series for temperature and precipitation are analysed and possible trends and variations are assessed for the time window 1981–2010, as well as the entire time line of the respective gridded dataset. Preliminary analyses reveal that the 2m air temperature and Dst index has changed over time, whereas the 500 hPa temperatures do not portray this trend clearly. Seasonal analysis for the same time window for the 500 hPa temperatures show a clear negative linear trend for spring (MAM), summer (JJAS) and autumn (SON) temperatures. Precipitation amounts seem to have significantly decreased in MAM and JJA for the period 1981–2010.

As gridded datasets are prone to inhomogeneities, an ensemble of observational and reanalysis datasets are analysed and possible trends and uncertainties are discussed. In conclusion it is important to state that global observational datasets and reanalysis are not a surrogate for ground and upper air in-situ measurements and allow only a very coarse estimation of actual long-term trends. Nevertheless, it often remains the only option for local studies.

P-1117-24

J. Lukovic (1); B. Bajat (2); D. Blagoevic (2); M. Kilibarda (2)
(1) University of Belgrade, Department of Geography, Belgrade, Serbia; (2) University of Belgrade, Department of civil engineering, Belgrade, Serbia

This study examines a spatial pattern of annual, seasonal and monthly rainfall trends in Serbia. The study used data from 63 weather stations between the period of 1961–2009. The rainfall series was examined by applying the nonparametric method of the Mann–Kendall test and Sen’s method to determine the significance and magnitude of the trends. Significant trends have not been detected for the whole country at an annual scale. Seasonal trends at the confidence level of 97.5 %, however, indicate a slight decrease in winter (5 stations out of 63) and spring (7 stations out of 63) precipitation and an increase in autumn precipitation (10 stations out of 63). Results for monthly rainfall trends also generally showed a nonsignificant trend with the exception of a negative trend in May (6 stations out of 63) and positive trend for October (9 stations out of 63). Calculated global autocorrelation statistics (Moran’s I) indicate a random spatial pattern of rainfall trends on annual, seasonal and monthly timescales with exceptions for March, June and November. Overall, results suggest that only weak, mostly nonsignificant trends are present in Serbia in the period 1961–2009. Trends of rainfall data are used to produce spatial maps of recent rainfall trends web mapping techniques are used applying recently developed package plotGoogleMaps.

P-1117-25
Evaluation of regional climate models in the context of AGRHYMET

M. Ly (1)
(1) AGRHYMET Regional Centre, Training and Research, Niamey, Niger, Republic of

The AGRHYMET Regional Center is a specialized institution of the Permanent Interstates Committee Drought Control in the Sahelian CILSS member states. It has the objective to contribute to achieve food security for agroclimatological and hydrological applications with emphasis on rural and natural resource management. It contributes to achieve food security for increasing agricultural production in the CILSS member states by providing training and information to stakeholders and partners. For these missions some innovative projects have been initiated in the recent years to help countries to achieve the Millennium Development Goals (MDG) throughout their ability to analyse the climate change impacts. In this regard AGRHYMET has just initiated a comparative regional climate modeling studies for the present and future climate for identifying the climate related risks in the main sectors and provide information for decision–makers. In the Sahel, food security is highly reliant on rainfall agriculture, and thus the intra–seasonal variability of rainfall including the onset dates, the cessation dates, the length of the rainy season remain an
important factors to investigate. The aim of this work is to provide initial evidence on current and probable future climate conditions, for use by decision makers in the region. It will also enhance the capabilities of the above mentioned characteristics of the rainy from regional general circulation simulations. Some approaches are then used in the region through the regional seasonal outlook forum (PRESAO) to determine a suitable planting date aiming to minimize the water stress in the growing period and then optimizing the staple crop yields in the Sahelian and the guinean cost countries. The exercise is focusing to analyze the divergence of regional climate models in the CORDEX experiment on intra-seasonal variability of daily rainfall and the likely occurrence of long dry or wet spells during the critical growth of the dominant crop varieties sown by West African farmers. The project outputs will contribute to significantly lower uncertainties by developed better and more tailored climate change knowledge to inform the user communities on climate related risks, as well as enhance their resilience to food insecurity and other climate related disasters.

P-1117-26

Effects of Drastic climatic variability in Pakistan

U. Mehmoed (1); U. Aslam (2)

(1) University of Management and Technology, Department of political science, Lahore, Pakistan; (2) university of the punjab, Lahore, Pakistan

Weather and climate have very important socio-economic impacts. Climate of Pakistan have become unpredictable. This study describes the effects of intense flooding during 2010 and severe drought since December 2013 in Pakistan. Because of rapidly growing population and industrialization in Pakistan, the waste material is getting into the atmosphere and contaminating it and producing greenhouse gases. In late July 2010, heavy monsoon rains in Pakistan increased the water level in Indus River which caused heavy flooding in southern Pakistan. During the wet spell from 27 to 30 July Risalpur, Islamabad, Peshawar, Lahore, and Rawalpindi received rainfall of 411 mm, 294 mm, 333 mm, 288 mm, and 219 mm respectively. More than one fifth of Pakistan land was under water and 20 million people were affected and there was a large-scale destruction of property, livelihood, and infrastructure. On the contrary, currently most of the areas of southern Pakistan (i.e. Tharparkar district) are facing a severe drought since December 2013. More than 120 malnourished children have died and about 240,000 families have been affected and some of them have been forced to leave their homes and move to barrage areas. There is need to explore the causes of climatic variability and sophisticated methods of weather forecasting so that damages can be minimized to a greater extent.

P-1117-27

Climate Variability and Waterborne Diseases: Case of Typhoid Fever and Enteric Viral Hepatitis in Meknes city, Morocco

O. Mouhaddach (1); A. El Yaacoubi (1); I. Boularab (1); M. Bend-Daoud (1); M. Kemestont (2); S. El Jaafari (1)

(1) Moulay Ismail University, Faculty of science, Meknes, Morocco; (2) Catholic University of Louvain, Louvain-la-Neuve, Belgium

Background: In spite of all efforts deployed by health officers to control the waterborne diseases, Meknes still the most severely affected province in Morocco. Various officers to control the waterborne diseases, Meknes stills stated that diseases in this area.

Therefore, this study was carried in Meknes province and aims to understand the impact of climatological factors on typhoid fever and enteric viral hepatitis transmission, and to highlight the relation between climatological and environmental factors in this case, over the period 2004–2013.

Methods: Due to non-normal distribution of our input data, Spearman correlation was used. In order to point out the relevant periods of the year where the infection by Salmonella typhi and hepatitis viruses A & E, was strongly correlated to climate conditions, namely air temperature and rainfall, a new statistical approach was used, Partial Least Squares.

Results: The results reveal a temporal periodicity of typhoid and enteric viral hepatitis recorded cases, and the presence of significant positive correlation between the studied factors and the cases.

Partial Least Squares regression showed two relevant periods where the number of typhoid and viral hepatitis recorded cases increased, in coincidence with rise of air temperature and decrease of rainfall. The first period started from the end of March to the beginning of June, while the second one extended from the beginning of August to the end of October.

In fact, need of water for irrigation is more required during these two periods. The project outputs will contribute to significantly lower uncertainties by developed better and more tailored climate change knowledge to inform the user communities on climate related risks, as well as enhance their resilience to food insecurity and other climate related disasters.

Conclusion: This study identified some of climatological and environmental determinants of waterborne diseases in Meknes Province which currently exhibits the highest incidence in Morocco. This knowledge can be used to design intervention measures to reduce and control the said diseases in this area.

P-1117-28

Evaluation of model simulation of the Southeast Asia climate under the SoutheEast Asia Regional Climate Downscaling (SEACLID) CORDEX Southeast Asia project

G. Narisma (1); F. Cruz (2); J. Dado (3); F. Tangang (4); L. Juneng (4); T. Phan Van (5); T. Ngo-Duc (5); L. Trinh-Tuan (5); T. Nguyen-Xuan (5); J. Santhi (6); Sam Tran (6); P. Singhruck (7); D. Gunawan (8); E. Aldrian (8); JX. Chung (4); ST. Ngai (4); TW. Teh (4)

(1) Ateneo de Manila University, Physics Department, Quezon City, Philippines; (2) Manila Observatory, Quezon City, Philippines; (3) Tokyo Metropolitan University, Department of geography, Hachioji, Japan; (4) National University of Malaysia, School of environmental and natural resource sciences, Bangi, Selangor, Malaysia; (5) VNU Hanoi University of Science, Hanoi, Vietnam; (6) Ramkhamhaeng University, Bangkok, Thailand; (7) Chulalongkorn University, Bangkok, Thailand; (8) Agency for Meteorology, Climatology and Geophysics, Jakarta, Indonesia

In the face of future climate change impacts, high-resolution climate projections are essential in developing appropriate adaptation and mitigation responses. The Southeast Asia Regional Climate Downscaling CORDEX Southeast Asia (SEACLID/ CORDEX-SEA) project aims to generate these projections through a collaborative effort in regional climate downscaling. Over the Maritime continent, which may either be due to the model or to uncertainties in the observation data used. Results also indicate relatively higher similarities for both seasonal and inter-annual variabilities in the temperature and rainfall extremes among the different model experiments performed over mainland Asia compared to the Maritime continent. These results are a step forward in understanding and appropriately configure the regional climate model, particularly for the SEA region.
Atmospheric Systems and Thermical Comfort Index in Presidente Prudente (Brazil) in January-March 2014 period

M. Noli Da Fonseca (1); MC. Silva, (2); PRD. Alves, (1)
(1) UFPR, Curitiba, Paraná, Brazil; (2) UFPR, Curitiba, Brazil

Since humanity’s beginnings man has a concern with the phenomena that originate in the atmosphere. The city of Presidente Prudente is located in the western portion of the state of São Paulo, with a population estimated at 218,960 inhabitants (IBGE, 2013). The city is situated at an altitude of 472m above sea level and has a great diversity of land use, because the neighborhoods are densely built. With regard to the climate, the city is located in a tropical climatic system, a climate transition area, that is, the end of the monsoon region is present in South America. Thus, this research is to identify the performance of weather systems and its relation to the thermal comfort in the city of Presidente Prudente in the quarter January, February and March 2014.

For this purpose, we applied initially to Rhythmic Analysis methodology developed by Monteiro (1971) and index calculations Thermal Comfort. Given this, it was found that the feeling of «great discomfort» prevailed during the three-month study, and in the second half of January and the first half of February this feeling was linked to the phenomenon atmospheric, which caused an increase of up to 5 °C in temperature and made cities registrassem record highs. Moreover, the action of «atmospheric blocking» and the daytime heating caused the sensation of «moderate discomfort» was set up, which is active mainly in the afternoon.

Analysis of the Effects of Climate Variability on Crop Yield in Imo State of Nigeria

F. Okorie (1)
(1) Imo State University, Owerri, Geography and Environmental Management, Owerri, Imo State, Nigeria, Federal Republic of Nigeria

Agriculture is one of the sectors that are strongly affected by climate variability and change especially in developing countries. In Nigeria, it is well known that the country has varied climate and space, and it will continue to vary in future. Many variations in rainfall particularly have occurred for the different climatic regions and individual locations in Nigeria. In the Southern part of Nigeria, for example, drought has been relatively less persistent, while rainfall is observed to be increasing and temperature increases and reduces moderately over the years compared with other states in the Northern parts of the country. Many parts of Imo state in Southeastern Nigeria experience flood disasters following excessive rainfall which destroy their farmland and wash away their crops. One major issue with respect to climate variability involves its influence on crop yields. Some studies have shown that fluctuations in rainfall and temperature regimes are the atmospheric driving forces that are responsible for the changes in the climate systems which affects the country’s other important sector, the Southeastern Nigeria. The yield and quality of food crops is central to the well-being of humans and is directly affected by changes in climatic systems. Climate variability affects crops yields ultimately, uncertainties in the onset of the post-monsoon and pre-monsoon cropping season due to changes in rainfall characteristics (early rain may not be sustained and crops planted at that instance may become smothered by heat waves) can lead to an unstable election of crops. The deficit of rainfall, droughts have been observed on a national scale. Extreme weather events such as thunderstorms, heavy rainfall and extreme temperature also devastate farmlands and leads to poor yield of crops. Pest and disease occurrence is strongly influenced by climate variability. In the study, 15 years (1999–2013) climatic data (rainfall and temperature) generated from the archives of Nigeria Meteorological Agency (NIMET) and crop yield data on selected crops from Agricultural development program (ADP), Owerri, Imo state were examined. After data analysis, the result shows fluctuations in temperature and rainfall pattern in the state with negative effects on crop yield, which also affects humans socioeconomically. Based on this, it is suggested that farmers should adopt good farm management techniques in order to adapt to the prevailing climate variability.

Spatial and Temporal Variability of Precipitation over the Gandaki River Basin of Nepal Himalaya

J. Panthi (1)
(1) The Small Earth Nepal (SEN), Research, Kathmandu, Nepal

Landslides, floods, and droughts are recurring natural disasters in Nepal related to too much or too little water. The summer monsoon conveys most of the rainfall in two thirds of the country. Rainfall is very irregular, 40% of annual rainfall, and rainfall spatial and inter-annual variation is very high. The Gandaki River, one of the three major rivers of Nepal and one of the major tributaries of the Ganges River, covers almost 60% of the population of the central part of Nepal. Time series tests were applied for different agro-ecological zones of the Gandaki River Basin (GRB) for rainfall trends of four seasons (pre-monsoon, monsoon, post-monsoon, and winter) from 1981 to 2012. The non-parametric Mann–Kendall and Sen’s methods were used to determine the trends. Decadal anomalies related to the long term average were analyzed using the ANOVA-OTTIE precipitation product. Trends in number of rainy days and timing of the monsoon were also analyzed. We found that the post-monsoon, pre-monsoon and winter rains are decreasing significantly, whereas the monsoon rains have increased throughout the basin. In the hill region, the annual rainfall is increasing but the rainy days do not show any trend. There is a tendency of the late departure of monsoon from Nepal, indicating an increase in its duration. These seasonally varying rainfall patterns have a significant influence on the annual crops. Thus, it is important to have an understanding of the variations in rainfall and the number of rainy days for crop production planning.
Early warning of climate variability and change from seasonal forecasts

KA. Peterson (1); A. Scaife (1); C. Maclachlan (1); A. Arrabas (1); A. Maidens (1); M. Gordon (1); A. Brookshaw (1); J. Camp (1); D. Fereday (1)

(1) Met Office, Hadley Centre, Exeter, United Kingdom

Projections of future climate suggest that extreme events such as drought, floods, storms, cold spells, and heatwaves will all change their regional frequency of occurrence due to long term climate change. However, on planning timescales of months to years in advance, the timing and occurrence of extreme or unprecedented events is harder to predict. In particular, projections depend on the superposition of climate variability and climate change. In order to advise on the risk of imminent extremes we therefore need climate predictions which accurately take into account current climate variability. This requires initialisation of the current state of the climate in the atmosphere, ocean, sea ice, and land surface as well as the changes in radiatively active greenhouse gases and aerosols.

Here we discuss near term climate predictions from the Met Office Hadley Centre out to seasonal lead times. We show evidence of predictability of the leading modes of climate variability over West Equatorial Africa (WEA) from Southwestern Pacific to the north Atlantic and the extratropics (North Atlantic/Arctic Oscillation). We show how this can lead to predictability for regional climate extremes and discuss the prospects for improved warnings and adaptation to imminent extreme events.

Ability of a high regional climate model to represent key climatic features over West Equatorial Africa

W. Pokam (1)

(1) Department of Physics, Higher Teacher Training College-University of Yaounde 1, Physics, Yaounde, Centre, Cameroon

Climate dynamics over West Equatorial Africa (WEA) is dominated by four prominent features. At lower level, two cells of westerlies (LLW) are discernible, controlled by different mechanisms. At middle level, African easterly jet prevails with a northern component (AEJ-N) discernible year round, and a southern cell discernible from September to February. The upper troposphere is dominated by the Tropical Easterly Jet (TEJ) which drives over WEA a prominent role on the variability of the atmospheric dynamic over the region.

This underlines the complexity of atmospheric features over WEA, and the requirement of fine scale climate model for investigating locally driven atmospheric circulation. High resolution (25 km) regional climate model HadRM3P was evaluated in its capacity to capture and model key dynamical features over WEA.

Results show the ability of HadAM3P to reproduce features related to the development of the two cells of LLW over WEA. HadAM3P do well in locating the core speed of the two cells of LLW and simulate well their annual variability. HadRM3P does a well job in simulating characteristics of AEJ-N and AEJ-S. The height of the core speed of the two components of AEJ is well simulated, together with their annual latitudinal migration. In upper troposphere, TEJ is well captured by HadRM3P.

However, some biases appear in the simulations. Investigation of the reasons behind these biases leads to highlight the need to improve the representation of coastal region in WEA. This leads to overestimation of local vertical convergence of sensible heat flux from the surface, inducing a warm bias of diabatic heating. This promotes positive bias of vertical motion and in turn overestimation of LLW. This reveals the need to improve over coastal region in WEA for the development of LLW.

Analysis show that during the main rainy season over WEA, from September to November, the prominent feature for the development of uplifts is diabatic heating release by condensation throughout the depth of the troposphere over WEA, rather than jet streak type circulation associated to the development of AEJ-S and AEJ-N.

Stochastic Dynamical Cascade for Downscaling Precipitation signals over Complex topographies in the High Andes

A. Posadas (1); E. Duffaut (2); C. Jones (3); L. Carvalho (3); M. Cardoza (4); H. Heidinger (3); R. Quiroz (5)

(1) International Potato Center, Production System and Environment/ICRAF, Nairobi, Kenya; (2) Electrical and computer engineering department, Purdue University, West Lafayette, Indiana, United States of America; (3) Earth Research Institute, Department of geography, Santa Barbara, California University, United States of America; (4) International Potato Center, Crops systems intensification and climate change, Lima, Peru

Global Climate Models (GCMs) suggest that rising concentrations of greenhouse gases will have significant implications for climate at global and regional scales. Less certain is the extent to which meteorological processes at individual sites will be affected. Downscaling climate techniques are used to bridge the spatial and temporal resolution gaps between what climate models are currently able to provide and what decision-makers require. Among the most important impacts of regional-scale prediction of climate change is to assess how food production will affect the food security. Regional scale precipitation and temperature downscaling is crucial to help crop models in understanding how global warming will affect fresh water storage and the ability to grow agricultural crops. Precipitation and temperature downscaling improve the coarse resolution and poor local representation of global climate models and helps decision-makers to assess the likely hydrological impacts of climate change, and it would also help crop modelers to generate more realistic climatic-change scenarios. Thus, a spatial downscaling method was developed based on the multiplicative random cascade disaggregation theory, considering a β-lognormal model describing the rainfall precipitation distribution and using the Mandelbrot-Kahane- Peyriere (MKP) function. The Multifractal downscaling technique, complemented by a heterogeneity filter, was applied to a 15 years (01/11/1998 - 03/31/2013) daily rainfall time series produced by the Weather Research and Forecasting model (WRF – 15 km grid spacing). A downscaled signal of approximately 1 km grid spacing was generated for a 220 km x 220 km region within the high plateau of the Andes. The model parameters were estimated from gauged daily rainfall data registered over 15 years from 18 weather stations. A detailed testing of the model was undertaken by comparing statistical characteristics of the spatial and temporal variability of rainfall between the rainfall fields obtained from the rain gauge network and those generated by the simulation model. The potential advantages of this methodology are discussed.
aerosols can affect the large-scale atmospheric circulation and environmental issues that can be affected by climate change using the annual climate types from the Köppen–Geiger classification and the catalog situations of Hess–Brezowsky, to assess the dynamics and evolution of heat waves and heavy precipitation.

1. Annual climate types in Lyon since 1922

The Köppen–Geiger classification is the most used method to categorize the earth’s climates. The methodology used is the one detailed in Kottek et al. (2006) and Rubel and Kottek (2010). Rainfall and temperature data are from the weather station of Lyon–Bron (Météo France). The annual climate types is calculated, for each year (1922–2013), and analyzed by decades. All years are placed in the category of warm temperate climate, with the exception of 1945, 1948, 1994, 1998 which have a snow climate. Regarding temperatures, two types are identified in Lyon since 1922: warm and hot summer. There has, since 1965, a strong increase of the years with hot summer at the expense of warm summer. Concerning rainfall, the proportion of dry winters is constant with about 20% of the years of this type by decades. Fully humid and dry summer years have high variability for the decades before 1995, where they are simultaneously observed in these categories (up to 40% each). This first study on rainfall is complemented by studying the evolution of the weather types causing rainfalls, using the Hess–Brezowsky classification.

2. Rainfall atmospheric patterns evolution since 1881

Greater Lyon floods are caused by rainfall with different characteristics. Their natures (intensity, water height, duration) are known since 1888 thanks to the Lyon 30 rain gauges network. In addition, rain is measured daily, since 1881, using Lyon–Bron station. The second part of this study relates the different types of rainfall to atmospheric circulation, and highlights trends related to climate change.

A comparison of many atmospheric circulation type catalogs has been made, and the method of Hess–Brezowsky (Gestengarbe and Werner 1999, 2005) was chosen to identify the types of rainy weather and its evolution. Since 1881, most of the rainfalls occur with southerly (22%) and westerly (31%) circulations. However, most of extreme rainfalls in terms of intensity, water height or duration are due to southerly, with 57 %, 47 % and 34 % respectively. Concerning the evolution of synoptic circulations since 1881, it is noticed a sharp and steady decrease of north–west and north regime, as well as southerlies and southeasterlies, whereas southerlies regimes have strongly increased, going from 20% of rainy weather in 1881 to about 45% in 2013. Regarding intense precipitation and focusing on the sub-types of circulation (Gustetterler or GWLs that ridge across Central Europe) is the most frequent, with a strong increase since 1881, according to the Mann–Kendall trend test. This is the same results for the «cyclonic south-westery» and «trough over western europe» GWLs that have strongly increased since 1881. According to these results, it can be expected an increase in hot summer and


P-1117-40

Average Bias of Diurnal Precipitation Over Maritime-Continent

F. Royan (1)

(1) Indonesian Agency for Meteorology Climatology and Geophysics, Research and Development Center, Jakarta, Indonesia

Numerical simulation of diurnal precipitation over maritime-continent were investigated using WRFv3.5.1. The numerical model use input data from GFS and from CRU ECCA data then the average bias from both input data shows that the precipitation is bigger in the afternoon until morning from 12 UTC until 00 UTC. In Maritime-Continent precipitation are on southern part of Indonesia. In June, most of the diurnal precipitation are almost around Indonesia, in September, most of the diurnal precipitation are on northern part of Indonesia and in December, most of the diurnal precipitation are around Indonesia, except south of Java. It’s also revealed that, the diurnal precipitation over ocean is strongest in June rather than Land.

P-1117-41

Spatio-temporal characteristics of the recent rainfall recovery in West Africa

S. Sanogo (1); A. Ba (1); AH. Fink (2); JA. Omotosho (3); R. Redi (4); V. Ermert (4)

(1) Université des Sciences des Techniques et des Technologies de Bamako (USTT–B), Faculty of science and technique (fst, der-physics), Bamako, Mali; (2) Karlsruhe Institute of Technology (KIT), Institute of meteorology and climate research Karlsruhe, Germany; (3) Nigeria Institute of Technology, Akure, Wascal graduate research programme in west african climate system, Akure, Nigeria; (4) University of Cologne, Institute of geophysics and meteorology, Cologne, Germany

Using daily (monthly) rainfall data from 167 (254) stations across West Africa with at least 80% data availability for the 31-year period 1980–2010 and the gridded African Rainfall Climatology Version 2 (ARC2) for the period 1983-2010, linear trends in yearly and monthly rainfall totals were investigated. Measures of the Expert Team on Climate Change Detection and Indices (ETCCDI) and two rainy season onset and treat definitions were employed to assess the corresponding trend in frequency and intensity of daily rainfall and changes to monsoon season length. A rotated Empirical Orthogonal Function analysis yielded two homogeneous rainfall regions, the Sahel and Guinea Coast, in terms of interannual to decadal rainfall variability, and this led to analysis of station data and Standardised Precipitation Index data for the two regions. Results show that the majority of stations in the Sahel between the West Coast and 15° S shows a statistically significant positive rainfall trend for the period 1983–2010. The August-October period exhibits the largest rainfall recovery in the Sahel and the date of the treatment of the rainy season significantly moved later into the year by 2 days per decade. The recovery is reflected in longer wet periods with longer wet spell duration and more extreme rainfall events. Trends along the Guinea Coast are weak and non-significant except for extreme rainfall related indices. This missing significance is partly related to the hiatus in rainfall increase in the 1990s, but also to the larger interannual rainfall variability. However, the tendency towards a more intense second rainy season suggests a later withdrawal of rains from the West African subcontinent. ARC2 trends are broadly consistent with gridded datasets with ground calibration was undertaken, but are dubious for Nigeria and Ghana, and especially for the Guinea, Jos and Cameroon Lines, highlands due to missing gauge data.

P-1117-42

Characteristics of Hydro-Climatic variables in Nigeria during episodes Of Sea Surface Temperature Anomalies in the Gulf of Guinea

M. Sholademi (1); A. Sholademi (1)

(1) Nigerian Meteorological Agency, Applied Meteorological Services, Lagos, Nigeria, Federal Republic of

This study examined the characteristics of hydro-climatic variables in Nigeria at various agroecological zones (Forest, Southern–Guinea–Savanna, Northern–Guinea–Savanna and Sudan–Savanna) during different episodes of sea surface temperature anomaly (SSTA) in the Gulf of Guinea (GOG) region. The study utilizes SSTA and continental climatic data spanning 40 years; and with the aid of advanced statistical analysis to determine onset of rain, cessation of rain, duration of rain and frequency of occurrence of rain day using rainfall - potential evapotranspiration data. Results showed that SST is critical to climate monitoring at the local, regional and hemispheric scales. The result further display how to enhance optimal schedule of farm operations, proper adaptation and mitigation practices against extreme weather events arising from observed warming trends in both the SST and the near air surface temperature. Further recommendation is made for SSTA as a forecasting tool in the prediction of hydro-climatic variables that is essential for optimal agricultural practices.

P-1117-43

Studies on Climatic parameter influencing milk production in Cattle in South West Nigeria

M. Sholademi (1); A. Sholademi (1)

(1) Nigerian Meteorological Agency, Applied Meteorological Services, Lagos, Nigeria, Federal Republic of

This study further advance the knowledge of climatic indices applicable to the mitigation strategies aimed at reducing the vulnerability of cattle milk production in south western Nigeria. It shows that milk production in the tropics is affected by environmental factors of which climate appears to be most critical. We adopted Cocheme and Franqui (1967)’s model of 0.1<P<0.5E lactation method. The experiment involved a 2x2x3 factorial arrangement of two cattle breed, two locations and three seasons. Analysis of variance (ANOVA), correlation and regression was used to test the strength of relationship between climatic parameters and milk yield. The result shows that sunshine duration and evaporation are the dominant climatic parameters affecting milk production irrespective of breed and location. Furthermore, milk production in the study area was highest during the dry season with mean value as (approximately 331  litres/cow/day). However, no significant interactive effect of cattle, breed, location and season on the lactation yield of cattle is observed in the study.

P-1117-44

Influences of climatic variability on coastal oceanography of benin

Z. Sohou (1); TC. Guidi (2); CL. Hinvi (3); R. Djiman (4); DE. Fiogbe (5)

(1) Benin Fisheries and Oceanographic Research Institute (RHOB), Biological Oceanography, Cotonou, Benin; (2) Institute of Technology Lokossa, University of Abomey-Calavi (Benin), Industrial engineering and maintenance chair of mechanical and energy, Lokossa, Benin; (3) Faculty of Agronomic Sciences, University of Abomey-Calavi, Faculty of Agronomic Sciences, Abomey–Calavi, Benin; (4) Fisheries and Oceanological Research Institute of Benin (RHOB), Physical oceanography, Cotonou, Benin; (5) Science and Technic Faculty of Abomey-Calavi University, Zoology department, Abomey–Calavi, Benin
In article are analyzed temporary ranks for average monthly air temperature at Cotonou station. The authors calculated correlation coefficients for humidity of air; air temperature; sea surface water temperature. Research of interrelations between sea surface temperature and the intensity of the ITCCZ changes on depth, allow to identify a mesoslon zone; gives the chance to understand distinctions within a year, concerning lifting of deep waters (upwelling). Also authors performed calculations of correlationcoefficiente between monthly bioproductive of a pelagic species of fish (Sardinellamaderensis), as «the upwelling indicator», with air temperature. In addition to that are represented fields of the oceanic correlates and the salinity, received with use of SURFER program.

Rectification of El Nino–Southern Oscillation into Climate Anomalies of Decadal and Longer Time Scales: Results from Forced Ocean GCM Experiments

DZ. Sun (1); T. Zhang, (1); Y. Sun, (2); Y. Yu, (3)
(1) National Oceanic and Atmospheric Administration, ESRL/PSD, Boulder, United States of America; (2) Chinese Academy of Sciences, Institute of oceanology, Qingdao, China; (3) Chinese Academy of Sciences, Institute of atmospheric physics. Beijing, China

To better understand the causes of climate change in the tropical Pacific on the decadal and longer time scales, the rectification effect of ENSO events is delineated by contrasting the time-mean state of two forced ocean GCM experiments. In one of them, the long-term mean surface wind stress of 1950–2011 is applied, while in the other, the surface wind stress used is the long-term mean surface wind stress of 1950–2011 plus the interannual monthly anomalies. The results show that the time-mean fields of the two runs are identical. The two experiments also use the same relaxation boundary conditions, that is, the SST is restored to the same initial value. In these two runs, however, are found to yield significantly different mean climate for the tropical Pacific. The mean state of the run with interannual fluctuations in the surface winds is found to have a cooler and wetter Equatorial zone near the Republic of Benin, Cotonou. Authors calculated correlation coefficients for humidity of air; air temperature; sea surface water temperature. Research of interrelations between sea surface temperature and the intensity of the ITCCZ changes on depth, allow to identify a mesoslon zone; gives the chance to understand distinctions within a year, concerning lifting of deep waters (upwelling). Also authors performed calculations of correlation coefficiente between monthly bioproductive of a pelagic species of fish (Sardinellamaderensis), as «the upwelling indicator», with air temperature. In addition to that are represented fields of the oceanic correlates and the salinity, received with use of SURFER program.

Changes induced by dust on West African Monsoon features

NE. Toure (1); A. Konare (2); KO. Ogunjobi (3); S. Silue (4); I. Diallo (5); A. Diedhiou (6)
(1) Universite Felix Houphouet Boigny, Abidjan, Ivory Coast; (2) Universite Felix Houphouet Boigny, Cocody, Abidjan, Ivory Coast; (3) University Cheikh Anta Diop, Ecole Superieure Polytechnique, Dakar, Senegal; (4) University Cheikh Anta Diop, Ecole Superieure Polytechnique, Dakar, Senegal; (5) Institute for Research for Development (IRD), LTH – University Grenoble Alpes, Grenoble Cedex 9, France

The generation and transportation of dust from North Africa are thought to modulate the West African Monsoon (WAM) timescale. In this study we investigated the relationship between the Saharan Air Layer located above Atlantic Ocean (OSAL) and WAM features, including Monsoon flow, African Easterly Jet (AEJ), and Tropical Easterly Jet (TEJ) over West Africa using the RegCM4 regional model. Toward this purpose, we performed two sets of experiments from 2000–2010, one including dust and one without dust effect over the West African domain, encompassing the whole West Africa and a large part of the adjacent Atlantic Ocean. An Intercomparison of the two simulations show that dust load into the atmosphere has an effect on both the wind and temperature structure at different levels. The observed dust effect is well captured during JAS seasons. These changes lead to (1) a westward shift and slight strength of AEJ core over tropical Atlantic which is associated to (2) a weak TEJ and (3) lastly to West African Monsoon penetration. The relationship between the prescribed Sea Surface Temperature, correlations have been found between Aerosol Optical Depths in OSAL and wind, suggesting that mechanism relationship between dust and WAM features is well reproduced by RegCM4.
Despite the effects of climate change being evident at a global scale, its negative impact will severely affect those communities highly dependent on natural resources. Significant discussion has been focused on the possibility that climate change will displace large numbers of nomadic pastoralists in the mountain world, but few multivariate studies have addressed this issue. High Mountain areas in the arid environment are extremely sensitive indicators of sometimes only slight changes in atmospheric circulation, and Asia as the most vulnerable mountains for climate change has already been affected by climate change impacts. Climate change, however, is not the only consequence. On the one hand, environmental changes have deep impacts on the traditionally nomadic population, their economy and lifestyle. Thus it is justified to speak of both cultural and socio-economic vulnerabilities that characterise the pastures’ changes in this area. Regional focus of this study is the Jammu and Kashmir mountain area in the north of India and its forelands. Although however, temperature and rainfall trends suggest an increase exposure of the Jammu and Kashmir Nomads to the environmental stresses. Thus, their adaptation strategies show a clear trend towards different forms of agriculture as a reaction to the climatic change and changing political and socio-economic pressures. This holds true especially for the so far under-researched mountain regions of Kashmir in the Himalayas.

The study examined the impacts of climate change on grazing land, livestock performance and examined the coping strategies of the nomadic to climate change. Multistage sampling technique was used to select 140 respondents for the study. Data were analysed using percentages, frequencies, tables and Chi square statistical tools. The result of the study showed that 37.5% of the respondents were between the ages of 51-60 years with an average age of 49.8 years. The results revealed that 67.5% of the pastoralists strongly agreed that the pattern of rainfall in recent time affects pasture availability. Consequences of the results is that there is a decrease in milk production and increase in livestock’s mortality rate respectively due to the effect of climate change. A significance relationship was established between factors of climate change and milk production of the herd (calculated $x^2 = 52.00$, tabulated $x^2 = 7.8147$, $p<0.05$). It is therefore recommended that the pastoralists be trained in forage conservation techniques. They should also be encouraged to pool their resources to enjoy economics of scale by the extension workers. Grazing reserves should be developed by the government to fast track the disposition of the pastoralists to sedentary life. It was also recommended that an establishment of each respondents’ production services should be stepped up, diversify their production to include crops and other sources of income generation and establish more grazing reserves.

**P-1117-49**

**Summer precipitation in Ukraine - observations, modeling and controlling factors**

V. Tymofeyev (1); V. Martazinova (2)

(1) Ukrainian Hydrometeorological, Kiev, Ukraine; (2) Ukrainian Hydrometeorological, Climatere and long-range forecast, Kiev, Ukraine

Summer atmospheric precipitation in Ukraine is studied via climatology, atmospheric circulation and simulation in operative and climate models. Climatology of summer precipitation in Ukraine is studied with special attention to recent decades within the existing severe droughts. Many uncertainties in climate models outputs are detected; showing difference between early and late summer, and heavy precipitation in extreme events. Types of mesoscale fields are given. Spatial inhomogeneity is found in precipitation indexes, showing great intraseasonal contrast, on the background of general seasonal warming. Early summer became much wetter in 2000s with numerous extreme events, and period from August till mid-August is much dryer causing greater frequency of droughts or heat waves in the last decades. In contrast, early period of global warming in 1970s–mid-1980s has been characterized by much drier climate in the early summer.

It is shown that it is convection intensification that resulted in significant growth in extreme precipitation and attenuation events is responsible for significant spatial in broader scale (also across Europe) and intraseasonal contrasts. Growth in extreme precipitation is detected in the latest decade due to deeper European trough with frequent cut-off lows, and its interaction with blocking high over central Europe that have deep impacts on the traditionally nomadic population, their economy and lifestyle. Thus it is justified to speak of both cultural and socio-economic vulnerabilities that characterise the pastures’ changes in this area. Regional focus of this study is the Jammu and Kashmir mountain area in the north of India and its forelands. Although however, temperature and rainfall trends suggest an increase exposure of the Jammu and Kashmir Nomads to the environmental stresses. Thus, their adaptation strategies show a clear trend towards different forms of agriculture as a reaction to the climatic change and changing political and socio-economic pressures. This holds true especially for the so far under-researched mountain regions of Kashmir in the Himalayas.

The study examined the impacts of climate change on grazing land, livestock performance and examined the coping strategies of the nomadic to climate change. Multistage sampling technique was used to select 140 respondents for the study. Data were analysed using percentages, frequencies, tables and Chi square statistical tools. The result of the study showed that 37.5% of the respondents were between the ages of 51-60 years with an average age of 49.8 years. The results revealed that 67.5% of the pastoralists strongly agreed that the pattern of rainfall in recent time affects pasture availability. Consequences of the results is that there is a decrease in milk production and increase in livestock’s mortality rate respectively due to the effect of climate change. A significance relationship was established between factors of climate change and milk production of the herd (calculated $x^2 = 52.00$, tabulated $x^2 = 7.8147$, $p<0.05$). It is therefore recommended that the pastoralists be trained in forage conservation techniques. They should also be encouraged to pool their resources to enjoy economics of scale by the extension workers. Grazing reserves should be developed by the government to fast track the disposition of the pastoralists to sedentary life. It was also recommended that an establishment of each respondents’ production services should be stepped up, diversify their production to include crops and other sources of income generation and establish more grazing reserves.

**P-1117-50**

**Instability intraseasonal of rainfall and its implications on agricultural activities in the middle of Benin Republic (West Africa)**

I. Yabi (1); S. Zakari (2); PAB. Chabi (2); F. Afouda (2)

(1) University of Abomey–Calavi, Department of Geography, Abomey–Calavi, Benin; (2) University of Abomey–Calavi, Department of Geography, Abomey–Calavi, Benin

Until now rainfed agriculture is the main occupation of the people and is the basis of socio-economic development of rural areas of Benin (food security, monetary income). Moreover, inter-annual scale is intensification of convective activity that is linked to the frequency and summer showers on the background of further warming; many uncertainties exist in future climate projections. Our own model of the atmospheric circulation change is developed, and scenarios are built, on the basis of smaller rate of near-surface warming and variable precipitation. Recommendations for sustainable development for national economy, mainly for agriculture are given.

Daily rainfall amounts of 4 stations (Dassa–Zoumé, Savalou Savé and Banté) for the period 1941 to 2010, observed by the National Direction of Meteorology (DNM), were used. Determining the beginning of the end and the length of the dry season was done according to the criteria Gueye and Sikakur (1992) by used by Sane et al. (2006). Similarly, the frequency analysis of the beginning and the end and the length of the seasons was made at the frequencies 8 years out of 10, 5 years out of 10 and 2 years out of 10 by calculating the cumulative frequency to better appreciate the effect of climatic change in the period (in season length) were verified by Pettit test at significance level $\alpha = 5\%$. Moreover, the frequency and magnitude of dry sequences (false start of the rains, drought pockets at the end of seasons) and extreme events (longer time rainfall) were analyzed (Zakari et al. 2012) to better characterize the qualities of the seasons.

On average, the first (large) rainy season lasts 120 days (3rd decade of March in the second decade of July–while the second (small) rainy season is longer than 70 days (3rd decade of August to October ). This distribution allows two crops seasons per year (farmers cropping calendars are modeled on this distribution), although the
second is short and uncertain. But in reality, the region is characterized by a high occurrence of late start of the rains (between 15 and 30% for the great season, between 10 and 25% for early season) and ends early (20 and 35% for the great season and 10 and 20% for early season). It follows a significant trend towards shorter lengths of the seasons, making the crop seasons uncertain. In these episodes add the appearance of dry spells especially at the beginning at the end of the seasons that negatively affect agricultural activities. The degradation of the quality of rainy season has increased since the 1970s in keeping with the decline in seasonal and annual rainfall totals. It should be noted that the relative improvement of annual rainfall totals recorded since the 1990s has not induced an improvement in the quality of agricultural seasons in the region. So the years considered normal (average) or even surplus concerned with intra-seasonal volatility rain. In this context of quality degradation rainy seasons, the region has per moment of high rainfall sequences in the heart of the seasons, causing disastrous floods for crops and / or harvests.

It is therefore appropriate that agricultural promotion policies and strategies integrate these intra-seasonal rainfall fluctuations while taking into account the knowledge and logical farmers in order to define strategies for adapting agriculture to climate change in this region.

Analysis of the West African Heat Waves and their Associated Dynamic Factors using Regional Climate Models Outputs

F. Yoroba (1); K. Benjamin (1); A. Diawara (2); A. Diedhiou (3); Y. Kouadio (4)

(1) University Felix Houphouet Boigny – Cocody – Abidjan, Physic, Abidjan, Ivory Coast; (2) University Felix Houphouet Boigny – Cocody Abidjan, Physic, Abidjan, Ivory Coast; (3) Institute of Research for Development (IRD), LTHI – University Grenoble Alpes, Grenoble Cedex 9, France

Diagnostics combining Regional Climate Models Outputs and Station–based temperature Data from 1962 to 2013 indicate characteristics signals of heat waves over the West Africa. These heat waves can be associated with the occurrence of the regional warm days during the January and February (DJF) and the specific atmospheric circulation like Saharan heat low. Heat waves for various continental locations are shown to occur as isolated spatial and temporal events, and not as part of larger–scale systems over continental–size domains. An examination of the physical processes associated with heat waves showed mutually consistent climatic relationships, such that heat waves were associated with reduced rainfall and consequently reduced soil moisture content, evaporation, and increased insolation at the surface. These combined changes created the surface temperature increase intrinsic to the heat waves.

1118a - Attribution of extreme events: How are high impact extreme events changing and why?

ORAL PRESENTATIONS

K-1118a-01

Are humans exacerating climate and weather extremes?

F. Zwiers (1)

(1) University of Victoria, Vancouver, Canada

This talk will review some of the recent research on extremes, pointing to aspects of changes in extremes in which we have higher and lower levels of confidence. The body of evidence indicating a human contribution to observed climate change has continued to strengthen as indicated by the 5th Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). This continued development includes an accumulating body of evidence suggesting that temperature and precipitation extremes have both changed in response to human influences on the climate. The research on temperature extremes is well established, with recent work indicating that temperature extremes have continued to warm over land despite the recent global warming "hiatus", and that anthropogenic forcing has substantially increased the odds of extreme warm years and summers, both globally and regionally. The evidence on precipitation extremes is less well established, although there is increasingly strong evidence that human influence is detectable in observations at the largest scales that are resolvable in available international compilations of daily precipitation records. In contrast, assessments of historical and projected changes in droughts and storminess remain cautious, due to both data limitations and uncertainty in process understanding and modelling. Despite uncertainties and limitations in knowledge, observed and projected changes in the simple temperature and precipitation indicators in which we have greatest confidence provide ample evidence that adaptation is required now, and that further adaptation will be required in the future under all RCP forcing scenarios.

K-1118a-02

Detecting and attributing impacts of recent climate change on multiple systems worldwide – certainties, uncertainties and new research questions

W. Cramer (1); G. Hansen, (2); M. Auffhammer (3); C. Huggel (4); D. Stone (5)

(1) Potsdam Institute for Climate Impact Research, Potsdam, Germany; (2) University of California, Berkeley CA, United States of America; (3) University of Zurich, Department of Geography, Zürich, Switzerland; (5) Berkeley Lab, Berkeley CA, United States of America

Due to rapidly growing scientific evidence, based on growing stocks of observations as well as on improved methodologies, it is widely accepted that recent climate change has triggered changes in numerous systems worldwide. Most cited examples concern hydrological systems, the cryosphere, and many biological systems in the ocean and on all continents. The recent IPCC assessment, which was based on an unprecedented trans-disciplinary community effort, found more widespread impacts than previous reports, covered a greater range of impacted system types but also identified regions and systems with insufficient research and monitoring effort. Updating the report, three key questions will be addressed: a) To which extent have human systems been impacted, either directly or through cascading impacts through natural systems? b) How much is known about impacts in poorly observed regions? c) To which extent can the impacts of anthropogenic climate change be distinguished from those of natural climate variability?

K-1118a-03

Attribution of extreme events: Taking attribution science to the limits

P. Stott (1)

(1) UK Meteorological Office, Hadley Centre, Exeter, United Kingdom

Around the World recent heatwaves, floods and droughts have demonstrated the vulnerability of citizens to such extreme weather. However, scientifically robust information about the extent to which recent extreme weather events can be linked to climate variability and change is often lacking. There is therefore a clear need to develop better information on weather and climate risks as part of the development of climate services to enable citizens to better deal with the effects of climate change.

This paper describes recent progress in developing the
ABSTRACT BOOK
International Scientific Conference 7-10 JULY 2015 PARIS, FRANCE

O-1118a-01

Attribution of record high daily temperatures in Australia in 2013

D. Karoly (1); M. Black (1); A. King (2); M. Allen (3); F. Otto (4); S. Rosier (5); S. Lewis (6)

(1) University of Melbourne, School of Earth Sciences, University of Melbourne, VIC, Australia; (2) University of Melbourne, School of Earth Sciences, Melbourne, VIC, Australia; (3) University of Oxford, School of Geography and Environment and Dept of Physics, Oxford, United Kingdom; (4) University of Melbourne, Oxford, United Kingdom; (5) NIWA, Wellington, New Zealand; (6) Australian National University, School of earth sciences, Canberra, Australia

There has been increasing scientific interest in understanding the climate factors associated with extreme weather and climate events. This has led to the series of special supplements in the Bulletin of the American Meteorological Society over the last three years on “Explaining Extreme Events from a Climate Perspective”. A wide range of extreme events has been considered in the studies included in these supplements, ranging from heavy rainfall and drought events to record hot and cold seasons. However, there have been no studies so far on the attribution of record high daily temperatures at single sites.

The Australian summer of 2012–13 was the hottest summer averaged across Australia since reliable records began in 1910. Lewis and Karoly (2013) showed that human influences on climate have very likely increased the likelihood of extreme summer average temperature across Australia such as in 2012–13 by at least a factor of five. Here we present an analysis of the contribution of human–caused climate change to the frequency of events such as record high daily temperatures that occurred across Australia on 7 January 2013 and in Sydney on 18 January 2013.

The recently launched citizen science distributed computing project weather@home ANZ (http://www.climateprediction.net/weatherathome/australia-new–zealand–heat–waves/) has generated very large ensembles of simulated regional daily weather data needed for the attribution of extreme events. By comparing the frequency of extreme daily temperatures in the model simulations for the 1960s to the 2000s, we estimate that anthropogenic climate change has increased the occurrence of extreme daily temperatures by 42%, but the uncertainty range includes no change or an increase by over 150% due to uncertainty in the pattern of anthropogenic warming. Further, we partition the impact of greenhouse gases to dynamic changes in atmospheric circulation and to thermodynamic increasing water loading, demonstrating that both mechanisms played a role. A hydrological model driven by the model–simulated precipitation gives similar increases in risk compared to precipitation driven by the model-simulated precipitation. The uncertainty range for the attribution includes no change or an increase by over 150% due to uncertainty in the pattern of anthropogenic warming. Given these river flows we estimate that anthropogenic climate change has increased the likelihood of extreme summer average temperature across Australia such as in 2012–13 by at least a factor of five. Here we present an analysis of the contribution of human–caused climate change to the frequency of events such as record high daily temperatures that occurred across Australia on 7 January 2013 and in Sydney on 18 January 2013.

O-1118a-03

Role of soil moisture vs. recent climate change for heat waves in western Russia

M. Hauser (1); R. Orth (1); S. Seneviratne (1)

(1) ETH, Zurich, Institute for atmospheric and climate science, Zurich, Switzerland

Using the framework of event attribution, anthropogenic climate change was found to have a discernible influence on the occurrence–probability of heat waves, such as the one in Russia in 2010. Soil moisture, on the other hand, is an important physical driver for heat waves as its availability has a large influence on the partitioning of the available surface net radiation into latent and sensible heat flux. The presented study links the major contribution of both controls, soil moisture and increasing greenhouse gas concentrations, on heat waves in the region of the 2010 Russian heat wave. This is done with a large number of ensemble members from climate simulations with and without interactive soil moisture for both, the 2000s and the 1960s. The simulations allow to determine the occurrence–probability of heat waves with and without the soil moisture–temperature feedback and to compare
O-1118b-01
Unreliable climate predictions overestimate attributable risk of extreme climate events
O. Bellprat (1); F. Doblas-Reyes (2)
(1) Catalan Institute for Climate Science (IC3), Climate Forecasting Unit, Barcelona, France; (2) IC3, Barcelona, Spain
Climate predictions are increasingly being used to attribute single extreme climate events to anthropogenic factors by retrospective predictions. The reliability of the systems to predict extreme events might be an important aspect in such an assessment, yet limited hindcast periods which cover only a small number of extreme events in the past inhibit a robust evaluation. Using an idealized framework based on a synthetic forecast model this limitation is here circumvented. The framework allows to perform large number of predictions and to compute the fraction of attributable risk (FAR) on extreme events. Varying the forecast reliability shows that unreliable climate predictions are prone to overestimate the FAR due to ensemble overconfidence, which leads to unrealistically small probabilities for the event to occur without climate change. We show under which conditions forecast reliability becomes important in the second- and third-order attribution. This provides an outlook for future event attribution systems using climate predictions.

O-1118b-03
Investigating human influence on Southern France heavy precipitation events
A. Riba (1); S. Thao, (1)
(1) CNRM–GAME, Météo France – CNRS, Toulouse, France
In spite of a relatively dry mean climate, the Mediterranean regions in Southern France use to experience heavy rainfalls over short durations – typically a few minutes to one day. If compared to the rest of mainland France, 10-yr return values of maximum daily precipitation are two to four times larger over this area. The 2014 fall season was particularly severe, with 11 events exceeding the 190mm/day threshold, flash floods and several fatalities.

The possible link between such events and anthropogenic climate change has not been specifically addressed so far. Several approaches might be proposed to deal with this issue, including the realisation of specific climate model experiments. Unlike many other studies, we only focus on past observations and investigate the significance of recent trends in such events. Trends are investigated in terms of magnitude, frequency, and extent of events. Some statistical challenges arise to properly account for spatial dependences among locations. While previous studies looked at trends locally or over a small neighborhood, here...
we propose an aggregated diagnosis for the whole region (about 100 stations). The consistency of these trends with the change simulated by state of the art climate models is also discussed. Main results suggest that observationally based estimates of the human influence on heavy precipitation events are still weakly constrained over such a limited area.

O-1118b-04

Attribution of the June-July 2013 heat wave in the southwestern United States

H. Shiogama (1) ; M. Watanabe (2) ; Y. Imada (3) ; M. Mori (2) ; Y. Kamae (1) ; M. Ishii (3) ; M. Kimoto (2)

(1) National Institute for Environmental Studies, Tsukuba, Japan; (2) the University of Tokyo, Kashiwara, Japan; (3) Meteorological Research Institute, Tsukuba, Japan

A severe heat wave occurred in the southwestern United States (US) during June-July 2013. To investigate the effects of natural variability and anthropogenic climate change on this event, we generated large ensemble simulations of possible weather using the MIROC5 climate model, a physical atmospheric model, and a model of natural agents, sea surface temperature (SST) observations and sea ice (SIC) observations’ both with and without human influence. It was suggested that both the anthropogenic warming and an atmospheric circulation regime related to the natural variability of SST and SIC made the heat wave event more likely. On the other hand, no significant human influence was found in atmospheric circulation patterns. These results were robust for two different estimates of anthropogenic signals on SST and SIC.

O-1118b-05

Attributing regional effects of the 2014 Jordanian drought to external climate drivers

D. Mitchell (1) ; R. Zaaboul, (2) ; K. Bergaoui, (2) ; F. Otto (1) ; R. Mcdonnell, (2) ; S. Dadson, (1) ; M. Allen (1)

(1) University of Oxford, Oxford, United Kingdom; (2) iCBa, Dubai, United Arab Emirates

Throughout 2014, the regions of Jordan, Israel, Lebanon and Syria have experienced a persistent drought with clear impacts on the local populations. In this study we looked at how the probability of such a drought has changed under climate change, with a specific focus on the flow rate of the Litani river and the water level of Lake Tiberious (aKA the Sea of Galilee). Both of which hold major societal, political and religious importance. To perform the analysis we make use of distributed computing power to run thousands of models years of 2014 with slightly different initial conditions. We use an atmosphere only model (HadAM3p) with a nested 50 km regional model covering Africa and the Middle East. These data are downscaled to 1 km. Two separate experiments and simulations, 1. For all known climate change models and 2. For a naturalised 2014 scenario where we assume humans never impacted the climate. For observations, we use station data obtained from the Jordanian Ministry of Water. Using a combination of these local station observations and model data we are able to make clear statements on the attribution of a 2014-like drought event to human causal factors.

O-1118b-06

Distinguishing natural and anthropogenic influences on extreme fire danger in Australia

M. Black (1) ; D. Karoly (1) ; T. Lane, (1) ; L. Alexander (2)

(1) University of Melbourne, School of earth sciences, Melbourne, Australia; (2) University of New South Wales, Climate change research centre, Sydney, Australia

In the aftermath of the 2013 Blue Mountains wildfires in New South Wales, Australia, the scientific community was faced with the challenge of quantifying the event’s link to different causal factors, including human–induced climate change. While there are a number of recorded attribution studies for temperature and precipitation–related events, no such study exists for fire weather.

This study investigates how the likelihood of extreme fire weather in south–east Australia has been changed due to the competing influences of human–induced climate change and modes of inter–annual climate variability. Our analysis benefits from the use of the recently launched wetweather@home – Australia–New Zealand–distributed computing citizen science project to generate very large ensembles of regional climate model simulations over Australia. The likelihood of extreme fire weather is estimated for different phases of the El Nino Southern Oscillation under present climate conditions and climate conditions with no human influences.

1118-POSTER PRESENTATIONS

P-1118-01

Contribution of soil initial conditions for the occurrence of the 2003 and 2010 heat waves

O. Bellprat (1) ; C. Prodhomme (2) ; F. Doblas–Reyes (2)

(1) IC3, Climate Forecasting Unit, Barcelona, France; (2) IC3, Barcelona, Spain

Dry soil moisture condition before both 2003 and 2010 heat wave over western Europe and Russia, respectively have been suggested to play an essential role on the occurrence of the event. In order estimated the impact of soil initial conditions on those two heat waves, we run two sets of seasonal hindcasts with the general circulation model EC–Earth2.3. The initialization of those hindcasts is done either using climatological or realistic land surface initialization in May, June, July and August using the ERA–Land re–analysis. Results show that the 2003 heat wave is predictable either with climatological or realistic land–surface initial condition and for all considered start dates. This feature clearly shows that the 2003 heat waves was predictable. Conversely, the 2010 heat wave is reproduced in May only if the land is realistically initialized, while in June the event is not predicted by none of the hindcasts. The present study will investigate the processes behind the occurrence of the two heat waves.

P-1118-02

Evaluation of Mechanisms of Extreme Temperatures over Europe and North America

I. Colfescu (1) ; S. Tett (1) ; G. Hegerl (1)

(1) University of Edinburgh, School of GeoSciences, Edinburgh, United Kingdom

The 20th century reanalysis is used to investigate changes in the monthly frequency, location and intensity of temperature extreme events during the first half of the 20th century for North America and Europe. Using composite analysis the main synoptic weather patterns associated to the events are identified in the 20th Century Reanalysis and compared to those associated with events in the latter 20th century. An assessment of the capability of CMIP5 models to simulate these extreme events and their mechanisms is also performed by comparing the model patterns with those obtained from the 20C reanalysis.

P-1118-03

Attribution of Extreme Summers in Northern Europe

B. Dong (1) ; S. Len (1) ; R. Sutton (1)

(1) NCAS–Climate, Department of Meteorology, Reading, United Kingdom

The summer climate of northern Europe exhibits large variability from year to year and on longer timescales. In extreme summers the region experiences heat waves, droughts, or floods. This presentation will discuss the characteristics and drivers of variability in northern European summers with a particular focus on the summer of 2012, which was a record wet summer in northern Europe and was associated with widespread flooding, and the contrasting warm dry summer of 2013. The wet summer of 2012 was not an isolated event but rather one in a cluster of wet summers that have occurred more
frequently in the 21st century than in the last decades of the 20th century. West European summers are associated with a southward position of the North Atlantic storm track and a negative phase of the Summer North Atlantic Oscillation, with the opposite pattern for dry summers. The magnitude of the seasonal variability in these features suggests a role for forcing from outside the dynamical atmosphere. Climate model experiments have been carried out to identify the drivers of variability and to attribute the factors that influence those periods. The results indicate that anthropogenic forcing, both through its direct impact, and through its impact on warming sea surface temperatures, has substantially increased the likelihood of hot summers in northern Europe. Establishing the impact on the likelihood of hot summers is more complex. Evidence suggests that changes in North Atlantic Sea Surface Temperatures were an important factor explaining the striking contrast between the summers of 2012 and 2013. The implications of these findings for future summers in northern Europe will be discussed.

P-1118-04

The extreme wet 2013/2014 winter season in Western Europe in a changing climate

N. Hempelmann (1) ; P. You (1) ; R. Vautard (1)

(1) Laboratoire des Sciences du Climat et de l’Environnement, Saclay, France

Southern UK and North Western France witnessed records of precipitation amount during the winter of 2013/2014. How this specific extreme seasonal event is linked to climate change remains a difficult issue, due to the large inter-annual variability of precipitation amounts. Using observational records and the new EURO-CORDEX regional climate projections ensemble, we find that over the regions hit by the 2013/2014 event, recent trends in winter precipitation have increased. The estimates from observations are consistent with those from climate simulations. The non-significant change of the return period of the seasonal precipitation is found to be reduced.

We also address the issue whether precipitation amounts would have changed across past decades as a result from external changes than those of the regional atmospheric flow, we used the methodology of circulation analogues, computed from anomalies of sea level pressure over the North Atlantic region. Seasonal precipitations in the regions under study are well reproduced by flow analogues. We find that extreme U.K. precipitations are associated with analogue flows taken in the early part of the century on average weaker than those taken from analogue flows in the past few decades.

P-1118-05

Climate change induced temporal variability of droughts in Ukraine – the role of North Atlantic Oscillation

V. Khokhlov (1) ; N. Yermolenko (1)

(1) Odessa State Environmental University, Hydrometeorological Institute, Odessa, Ukraine

We used the multiscalar drought index – standardized precipitation evapotranspiration index – to investigate spatiotemporal droughts variability caused by the climate change. The index was calculated using the 0.5 degree grid data on the temperature and precipitation for Ukraine. The two periods with different trends of global temperature - 1951–1980 and 1981–2010 – were used to reveal a climate change impact.

The analysis revealed the periods with moistest and driest conditions. The moistest years were registered in the end of 1970s – start of 1980s. Moreover, both the number and intensity of droughts increase significantly since 1980, especially for the Southern Ukraine. During the 2006–2009, the most extreme and long drought was observed in the Odessa region. The analysis also showed that hydrological droughts begin with some delay from the moist to the dry conditions.

The cross-wavelet transform was applied to reveal a connection between the droughts in Ukraine and teleconnection patterns in the North Atlantic. The analysis showed that the North Atlantic Oscillation (NAO) has a maximal effect on the droughts in Ukraine. The anti-phase relation is registered for the joint fluctuations with the periods 2–3 years and is most prominent in the Southern Ukraine. On the contrary, the NAO has a small impact on the Northern Ukraine. This fact can be explained by the orientation of main storm tracks for positive and negative phases of the NAO.

P-1118-06

Understanding the role of anthropogenic climate change behind changes in regional heatwaves

S. Perkins, (1) ; E. Fischer, (2)

(1) University of New South Wales, Climate change research centre, NSW, Sydney, Australia; (2) ETH Zurich, Zurich, Switzerland

Since 1950, heatwaves have been increasing in their intensity, frequency and duration over many global regions. This period of time includes the temperature "hiatus", where global average temperature did not significantly increase from 1998 to 2012. This study makes use of a 21-member of a single GCM to determine whether changes in heatwaves over various global regions are a result of anthropogenic, and whether observed changes in discrete heatwave events could have occurred without human influence on the climate.

The 21-member ensemble of the Community Earth System (CESM) global climate model is a novel tool, in that it provides a considerable estimate of internal climate variability that is not readily obtainable from most other model ensembles. Each of the historical and future simulations has identical prescribed external forcings, the former of which is based on observations. However, they differ only slightly in their atmospheric initial conditions, commencing on 1st January 1950. The multimodel simulations provide a unique sample of a large range of "possible" climates that are all equally plausible under the same external conditions and physical mechanisms of the model. This is distinctive from a multi-member model ensemble such as the 5th Phase of the Climate Model Intercomparison Project, where each participating model has a different physical set-up. Moreover, the version CESM employed in this study provides a 980-year control simulation, allowing for substantial research into climate conditions without influence from human activity.

Firstly, this study explores whether a hiatus occurred for regional heatwaves. Results show that for many global regions there is a large range in plausible heatwave trends during the ~15 year hiatus period, thus inhibiting the robustness of any one estimate, including that of observations. Next it is explored whether similar heatwave trends are possible without anthropogenic climate change. Similar to absolute changes heatwave intensity, frequency and duration, we conclude that the rate of change (i.e. trend magnitudes) in heatwaves since 1950 is primarily a result of human influence on the climate system.

Lastly, the fraction of attributable risk methodology (FAR) is employed to determine whether the likelihood of particular heatwave events have increased due to human influence on the climate. For all regions, it is very likely (>90% probability) that there has been a substantial increase in what is now considered the 1-in-20 year heatwave events. Moreover, for some regions, there is little evidence the current 1-in-20 year heatwave event would have occurred at all without anthropogenic activity. Such results highlight that there is already a signal in anthropogenic climate change in the extreme events we observe today.

P-1118-07

Scenarios for extreme climate characteristics

P. Szabo (1)

(1) Hungarian Meteorological Service, Climate modelling group, Budapest, Hungary
State-of-the-art regional climate models (RCMs) are the best tools to provide detailed and quantitative information about future climate change at regional and local scales since it describes physical processes affecting regional climate features in detail. The results obtained from a regional model of around 10-25 km horizontal resolution are of good basis for local impact assessments instead of using low resolution global climate model outputs. However, model simulations have different spatial and temporal scales. RCMs enable the community to derive the projection results together with their uncertainties for impact studies. To assess uncertainty in the simplest way, at the Hungarian Meteorological Service a two model approach was used for 100 year horizon. The REMO2009-Climate (25 km) run covering Central-Eastern Europe: REMO (25 km) adapted from Max Planck Institute for Meteorology and ALADIN–Climate (10 km) from Météo–France.

Local impact assessments are based mainly on daily minimum and maximum temperature (besides daily mean values). According to observational data, our local climate over Hungary is warming up more rapidly than the global temperature. The main question of our investigation is whether the record highs increase or the record lows decrease faster. Using observations we calculate how many record high daily maximum temperature and record low daily minimum temperature are set in each year over a grid point. Current record high to record low ratio is above one: it is around 3 to 1 in Hungary with an average of 3.6 in the last 5 years and 2.6 in the last 10 years. Relative increase of record highs to record lows is shown for the two locally-run RCMs from 1961 to 2100, however, the increasing ratio could eventuate that record lows could disappear in the whole country around the end of the 21st century.

We give results for the record high daily precipitation, as well. Compared to the theoretical stationary climate conditions, observations show only an intensification in the inter-annual variability of precipitation records in Hungary. The two models also do not expose robust results: only one model shows a clear increase in record high daily precipitation for the end of the 21st century.
Evolution rain-vegetation-agricultural yields in the watershed of the Bouregreg (Morocco) from 1980 to 2009

ZA. Tra Bi (1); G. Mahe (2); T. Brou, (3)
(1) Alassane Ouattara University, Geography Department, Bouaké, Ivory Coast; (2) Institut de Recherche pour le Développement, Milieu et Environnement, Montpellier cedex 5, France; (3) UMR 228 ESPACE-DEV (IRD, UM2, UAG, UR), Saint Denis, France

Bouregreg Watershed (central Northwest of Morocco) belongs to the agricultural area of Morocco. The agricultural area of the country is only 20% of its national territory, where a strong agricultural and pastoral attractiveness for wet areas like Bouregreg watershed. This watershed is subject to a Mediterranean semiarid climate. Precipitations that fall all year are unevenly distributed over the basin. Thus, the altitude is causing a significant rainfall contrast between Northeast parts of the basin where rainfall rising to 760 mm per year and Southwest areas where they drop to less than 350 mm per year. In addition, climate dynamics of this space, since the 1970s, is marked by strong climate variability with a downward trend in rainfall. This is a major concern for the agricultural production in this region, especially that agriculture is mainly rainfed. The crop production system is heavily influenced by the soil and climate conditions in Bouregreg watershed.

This study analyzes the interaction between changes in precipitation and dynamics of crop production from 1980 to 2009. It is a component of the SIGMED (project spatial approach to the impact of agricultural activities in the Maghreb on sediment transport and water resources in large river basins). The study focuses on the impact of droughts and wet periods on crop production. To achieve this goal, a time series of comparative statistical analysis is first performed on Normalized Difference Vegetation Index (NDVI) of NOAA (National Oceanic and Atmospheric Administration) and MODIS (Moderate Resolution Imaging Spectroradiometer), meshed in 8 km x 8 km, and rainfall series. In holding the large spatial variations in rainfall in the basin, the analysis is made by homogeneous climatic unit. Then, a special statistical analysis is performed on the dynamics of agricultural production, frequencies and intensities of agricultural drought. Droughts and their intensity are determined by linear regression of cereal production with a 95% confidence interval.

The analysis of the evolution of vegetation reveals significant interannual variation in plant activity (37% coefficient of variation), with a marked tendency to decline in the summer. A break in the dynamics of plant activity of the basin is observed in 1999. Reductions are 13% and plant activity by 1995. The largest droughts are located downstream, in the center and south of the basin. The analysis of changes in rainfall also highlights an interannual variation of 30 to 40%, with deviations from the average, greater than 120 mm. Paradigmatically in China, for which there is no annual downward trend in rainfall amounts in downstream, the center and the south of the basin, but in the northeast that is the wettest area of the basin. In addition, the observation of a significant decrease of vegetation in the summer is not correlated to changes in rainfall. For cons, the correlation between precipitation and vegetation change in wet period (growing season) is important. This analysis of the evolution of wheat (soft and hard) and barley agricultural droughts (the three grains representing ¾ of agricultural production of the basin) allows to notice a declining intra seasonal dynamic of rainfall and vegetation during this period. This decrease is particularly great between 1990 and 2002. Analysis of drought frequency for all three cereals allows concluding that the period from 1980 to 2009 was marked by eleven important agricultural droughts. The intensities of droughts between 1990 and 2002 are between 60 and 80% for these cereals. Thus, the high productions of certain grains such as wheat are mainly related to the conquests of new lands. Yield reductions are offset by an extension of cultivation areas at the expense of forests and fallow land. In addition, the overall decline in plant activity in summer is related to increasing grazing and thus to a rapid depletion of crop residues. This further leads to another pressure on forest vegetation and scrub.

Monitoring and seasonal forecasting of droughts in China

X. Yuan (1)
(1) Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing, China

Persistent hydrologic extreme events such as droughts have devastating impacts on the human and natural systems. Their occurrences are associated with anomalous atmospheric moisture transport which may be linked to variations of large-scale climate phenomena (e.g., ENSO), and their severities and durations are also influenced by land-atmosphere coupling that can enhance existing extremes. They may be further exacerbated by anthropogenic climate change and human water consumption. Improving our monitoring and forecasting capability of droughts, and facilitating adaptations through establishing climate service systems at regional to global scales, are among the grand challenges proposed by the WCRP, and are the core themes of the GEWEX/RHP. Focusing on the major river basins in China, I will show the quality of the latest satellite surface soil moisture retrievals produced by the European Space Agency Climate Change Initiative (ESA CCI) for drought monitoring, and the drought predictability and forecast skill based on North American Multi-Model Ensemble (NMME) climate forecast models.

As compared with in-situ observations at 312 stations in China and global reanalysis, the ESA CCI soil moisture products provide independent drought information over sparsely observed regions, and the active microwave product with better vegetation penetration works the best in southern China. Although remote sensing products can only detect less than 60% of drought months over in-situ stations, they capture the responses of inter-annual drought variations to ENSO at river basin scales quite well.

For drought forecasting using NMME models, the drought predictability is quantified by using a perfect model assumption. Drought predictability and forecast skill are positively correlated, but they vary depending on seasons, regions and forecast leads. Higher drought predictability is found over regimes where ENSO has more significant impact. For the ENSO-affected regimes, both drought predictability and forecast skill in ENSO years are higher than that in neutral years.

The outputs from NMME climate forecast models are bias corrected and downscaled to drive a hydrologic model to produce hydrologic drought (in terms of soil moisture or runoff anomaly) forecasts over river basins in China. Hydrologic hindcasts will be performed and evaluated against in-situ station observations and satellite products for a comprehensive analysis.
Extreme hydrological events: Deciphering changes in hazard and risk at different time-scales

M. Guimberteau (1) ; J. Ronchail (2) ; J.C. Espinoza (3) ; M. Lengaigne (4) ; B. Sergeant (5) ; L. Polcher (6) ; G. Drapeau (7) ; J.L. Guyot (8) ; A. Ducharme (9) ; P. Ciais (1)

The Amazon basin plays an important role in regulating the local and global climate since the discharge at its outlet contributes nearly 20% of global freshwater inputs (Callède et al., 2010). Streamflow changes have been characterized by severe extreme events, regarding floods as well as droughts (2005 and 2010) and floods (2002, 2009, 2012 and 2013). The populations living near the rivers whose activity is regulated by the present annual cycle of water are particularly sensitive to these extreme streamflow events. During high floods, boat trips are dangerous and the mobility of the populations is reduced. Severe low flows make the boat trips longer and increase fish mortality. Thus, food prices increase and directly impact the local economy. Given these facts, it is crucial to estimate the future of the hydrological extremes in the Amazon basin in a future warmer climate (between +1.5 and +5.0°C by 2100). The model ORCHIDEE (Organising Carbon and Hydrology in Dynamic Ecosystems) of the IPSL global climate model (GCM), is able to accurately simulate the present–time streamflow in many stations over the Amazon basin (Guimberteau et al., 2012). ORCHIDEE is then forced with 2xCO2 projections at sub-basin scale under future climate. Climate change scenarios over the Amazon basin were built with the delta downsampling method approach from up to eight AR4 GCMs based on three emission scenarios for two periods of the 21st century. For the middle of the century under a medium–emission scenario, no change is found in high flow on the main stem of the Amazon River, but low flows decrease by 1 to 3%. For the high–emission scenario, low flows decrease by 7%. By contrast, simulated decreases by 6.8% during the dry seasons over the southern, eastern and northern parts of the basin lead to significant low–flow decrease, especially in the Xingu River, where it reaches -50%. In the north, the
low-flow decrease becomes higher toward the east. Finally, the southern sub-basins, that have low runoff coefficients, will become more responsive to P change (increase in streamflow elasticity to P by up to 35%) than the western sub-basins, experiencing high runoff coefficient and no change in streamflow elasticity to P.


O-1119b-02

Fires in Amazon: Comparison between land use and palaeoclimatic changes
RC. Cordeiro (1) ; B. Turcq (2) ; P. Moreira-Turcq (3) ; L. Silva Moreira (4) ; A. Sifeddine (5) ; R. De Araújo Ribeiro Rodrigues (6) ; FFL. Simões Filho (7) ; C. Pagé (5) ; F. Habets (6) ; JM. Soubeyroux (1) ; P. Josse (2) ; JP. Vidal (3) ; E. Martin (4) ; C. Page (5) ; F. Habets (6)

Understanding the long-term variability in the intensity of intense storm activity is important for assessing whether changes are controlled by climate change. Understanding this variability is also important for predicting present and future community vulnerability and economic loss. Our ability to make these assessments has been limited by the short (less than 50 years) instrument record of storm activity. Storm-induced deposits preserved in the sediments of coastal lagoons offer the opportunity to study the links between high-temporal-resolution lumber industry and storm activity on longer timescales. In this study, we present a record of these extreme climatic events that have occurred in the French Mediterranean coast over the past 1500 years. The identification of these extreme events is based on the analysis of sediment cores from Gulf of Aigues-Mortes lagoons that contain a specific sedimentary and geochemical signature associated with intense storms. Overwash deposits do not show any evidence of intense storm landfalls in the region for several hundred years prior to the late 17th century A.D. The apparent increase in intense storms around 250 years ago occurs during the latter half of the Little Ice Age, a time of lower continental surface temperatures. Comparison of the sediment record with palaeoclimatic records indicates that this variability was probably modulated by the dynamics of extreme wind events along the French Mediterranean coast over the past 1500 years.

O-1119b-04

Characterization of drought and soil moisture in context of climate change: results and operational applications of ClimSec project in France
JM. Soubeyroux (1) ; P. Josse (2) ; JP. Vidal (3) ; E. Martin (4) ; C. Page (5) ; F. Habets (6)
Evolution of water resource is one of the main stakes of climate change in France. The Climsec project (2008–2011) focused on the impact of the climate on drought and soil moisture over France by using a high resolution climatological reanalysis since 1958 based from a Soil Vegetation Atmosphere Transfer model, the Safran/Isba/Modcou suite.

The high-resolution 1958–2008 Safran atmospheric reanalysis was used to force the Isba land surface scheme and the hydrogeological model Modcou. Meteorological droughts are characterized with the Standardized Precipitation Index (SPI) at time scales varying from 1 to 24 months. Similar standardizing methods were applied to soil moisture and the main multiscalar agricultural droughts – through the Standardized Soil Wetness Index (SSWI) – and multiscale hydrological droughts, through the Standardized Flow Index (SFI).

Based on a common threshold level for all indices, drought event statistics over the 50–yr period – number of events, duration, severity and magnitude – have been derived linking drought characteristics and drought events. This work highlights key differences at multiple time scales and at multiple levels of the hydrological cycle (precipitation, soil moisture, streamflow). Results show a substantial variability of temporal drought patterns over the country, strongly dependent on both the variable and time scale considered. Independent spatio-temporal drought events have been identified and described by combining local characteristics with the evolution of a regional drought index. The final work was too scarce past severe drought events, from multi-year precipitation deficits (1989–1990) to short hot and dry periods (2003).

Results show that the ranking of drought events depends highly on both the time scale and the drought index. This multilevel and multiscalar drought climatology served as a basis for assessing the impacts of climate change on droughts in France.

At the end of the project, the new drought indices were adapted for the operational hydrological monitoring and used for the qualification of drought event in real time, namely for the 2011 spring drought.

These indices were also calculated in future climate from the various regionalized climatic projections available over France. Three particular experiences in socioeconomic scenarios, climatic models and downscaling methods have been run to estimate the relative importance of different uncertainties for drought evolution.

In the same time, a diagnosis on drought evolution can be established with a schedule much shorter and more important for agricultural droughts linked to the deficit of soil wetness than for meteorological drought in relation with the precipitation. The climatic projections suggest that France could know at the end of the XXIth century a quasi-continuous drought with a strong intensity, totally unknown in the present climate.

Analysis hydrometeorological events of floods in the watershed Mono shared Benin-Togo (West Africa)

E. Amoussou (1) ; Y. Tramblay (2) ; SH. Totin Vodounon (3) ; G. Mahe (2) ; JE. Paturel (4) ; P. Ribstein (5) ; L. Descroix (6) ; M. Boko (7)

(1) University of Parakou, Geography, Parakou, Benin; (2) Université Montpellier 2, Irld, laboratoire hydrosciences montpellier, Montpellier, France; (3) University of Parakou, Geography, Parakou, Benin; (4) IRD, HydroSciences Montpellier, Abdijan, Ivory Coast; (5) Université Pierre et Marie Curie, Laboratoire hydrosciences de l’Ecole Polytechnique, Paris, France; (6) UMR PALOC, Lmi pateo, campus international de recherches ucad/ird de hann, Dakar–Hann, Senegal; (7) University of Abomey–Calavi, Geography, Abomey–Calavi, Benin.

The recurrence of extreme anomalies of precipitations involving of the floods or the droughts is a normal component of the natural variability of the climate. The harmful effects of the floods these last have strong incidences socio-economic and ecological and involved human losses of life and property damages. The vulnerability with these natural risks is high in West Africa and basin of Mono in particular, where the populations tend to occupy the most exposed zones more and more. The objective is to model the distribution of the risings entering to the dam Nangbeto thanks to hydrological model GR4J with the step of daily time to assess the risks of flood in the low valley of the river.

The data used cover the period 1961 to 2010. They is the daily outputs (m3.s–1), the evapotranspiration (mm/jour), calculated according to method FAO) and average precipitations on the basin (mm/day). The various methods of the interpolation of the rains were tested (linear, cubic, Thiessen, simple average). Model GR4J was useful with modeling of the risings upstream and the stopping of 1988 to 2010 to appreciate the effects of the dam.

The results show a marked variation in rainfall by increasing annual maximum daily followed by an increase in ETP. The rates recorded on output Nangbeto dam are equivalent to those recorded input, especially during floods, showing the weak regulatory role of the dam and the very limited capacity of the reservoir. The annual maximum incoming flow at the dam can be modeled by an extreme value distribution (GEV) Fréchet–type, while those measured at the outlet of the dam after a GEV law Weibull (bounded). The dominant runoff generation mechanism in the basin is the gradual rising waters associated with increased saturation of the soil, rather than isolated episodes of rainfall. The analysis of flood flows between 1988 and 2010 showed no increase in flood magnitude during this period. Finally the effective validation of the model with the reproduce GR4J) flood flows has been tested showing that the observed floods are simulated during calibration. However, validation tests over several periods with different climatic characteristics showed a degradation of performance criteria and the model as one moves away from the calibration period, showing the instability of the model parameters in the time. Under these conditions, the use of such a model to assess future risks future flood events is risky and it is necessary to consider alternative approaches.

**O-1119b05**

**Analysis hydrometeorological events of floods in the watershed Mono shared Benin-Togo (West Africa)**

**P-1119-01**

**Extreme rainfall analysis and water resources system sensitivity in Nigeria**

O. Adeaga (1)

(1) University of Lagos, Geography, Lagos, France

Climate change poses unique challenges to global socio-economic development and growth of the societies due to multiple shocks and stresses concurrently faced. This call for studies to estimate the potential impacts of climate change on the socio-economic systems. Extreme events today pose a serious threat to many populated and urbanized areas worldwide since anthropogenic climate change is now widely considered to have the potential not just to cause perturbations in the weather but also to create major discontinuities in many complex natural and human systems.

Hence, the need for an accurate estimate of frequency and distribution of extreme rainfall events can significantly aid policy planning in the area of land use planning and water resources system design that suits the harmonizing plan of their enormous physical structure and hydrological system. Quality precipitation information remains an indispensable requirement for warning systems, hydraulic structures design, risk assessment and hydrological modelling. Hence, reliable spatial information on precipitation distribution and pattern at finer climate information scale thus necessary. This information is required for warning systems, hydraulic structures design and modelling of the risks future flood events. However, the models of extreme events have been developed in the last decades, but the gaps between models and reality are significant. The main objective of this study is to estimate rainfall frequency and distribution in Nigeria and to assess the potential effects of extreme rainfall events on the water resources system sensitivities.
Groundwater induced flood estimation in extreme rainfall context; methodological approach applied to Somme basin (France)

N. Amraoui (1); J. Seguin (2)
(1) BRGM, Water environment & ecotechnologies division, Orléans, France; (2) BRGM, Orléans, France

Climate change is expected to modify hydrological cycle, and extreme events would be more frequent. Increasing extreme precipitation (frequency and intensity) projected in northern Europe and continental Europe (IPCC WG2 AR5 Chapter 21) would result in an increase of flood risk. In chalky basins located in northern France (Somme catchment) and the United Kingdom (Pang and Lambourn catchments), groundwater flooding, with return periods superior to 100 years has already occurred in winter 2000/2001. The estimation of groundwater contribution to flood peak under extreme rainfall context remains difficult because of a lack of appropriate methods and data. Nevertheless, this estimation is a decisive element for policy makers to assess and manage the flood risks.

In the Somme basin, a probabilistic approach to develop extreme events scenarios base on cumulative rainfall return period of 1000 years and hydrodynamic modeling of the groundwater and rivers system were used. A statistical extreme value analysis using a long rainfall time series allowed defining rainfall events of return period of 1000 years. Correlative analysis rainfall–discharge of the Somme river at the watershed outlet (Abbeville station) performed with cumulative rainfall over n days show that the best correlation is obtained with a total of n=180 rainy days. In addition, estimating the river discharge of return period 1000 years was made by fitting a probability distribution for extreme events (GEV law)

Several scenarios were simulated with the hydrodynamic model of the Somme basin; they differ in the temporal distribution of daily rainfall during the period of 180 days, the groundwater level at the onset of the rainy millennial episode, and the value of base flow of the river at the start of the rainy millennial episode.

The results highlight the rainfall distribution importance on the maximum discharge and the influence of the water table and the base flow of the river at the onset of the rainy period. It is also clear that for such climatic events, the groundwater contribution to the Somme river discharge remains important, between 65% and 72% of the flow remaining according to the scenarios.

Paleoclimate reconstructions over eastern Andes of Perú and Bolivia based on stable isotopes △18O of speleothems

J. Apaéstegui (1); F. Cruz (2); A. Sifeddine (3); B. Turcq (4); JL. Guyot (5); JP. Bernal (6); JC. Espinoza (7); M. Vuille (8)
(1) Peruvian Geophysical Institute iGp, Lima, Peru; (2) Instituto de Geociencias, Universidad de sao paulo, São Paulo, Brazil; (3) Institut de Recherche pour le Développement - IRD, Umr locean (ird/upmc/cnrs/Paris, France; (4) Instituto de Geociencias, Universidade de são paulo, São Paulo, Brazil; (5) Institut de Recherche pour le Développement, LOCEAN, Lima, Peru; (6) Centro de Geociencias, Universidad nacional autonoma de mexico, Queréataro, Mexico; (7) Instituto Geofisico del Peru, Lima, Peru; (8) University of Albany, SUNY, Albany, United States of America

During the last years, especial efforts on paleoclimate reconstructions have shown interest in the behavior of South American Monsoon System (SAMS) during the last 2 ky. Since there is considerable concern that the SAMS dynamics will be significantly affected by increasing greenhouse gas concentrations in the 21st century, there is an urgent need to improve document and understand the causes of Monsoon variations in response to natural forcing and human activities during the Holocene and most recent past periods. For instance, climate modeling studies and additional paleoclimate records of ocean and atmospheric conditions are needed to best define the relationships between SAMS rainfall and ocean-atmosphere variability during the late Holocene.

Moreover, it is worth noticing that is necessary to develop more proxies record in the southern hemisphere and key areas of the SAMS for better understand the climate system. Additionally, it is also important to reproduce these changes by coupled ocean-atmosphere models in order to define and recognize better relationships and mechanisms that could affect this system. These approaches would bring invaluable tools for define possible effects of climate change in SAMS and reduce population affected by extreme events in South America.

Extreme events effects on dissolved inorganic and organic carbon yields and fluxes in the watersheds of tropical volcanic islands, examples from Guadeloupe (FWI)

M. Benedetti (1); E. Lloret (2); C. Dessert (3)
(1) IPGP–SCP Univ. Paris Diderot, Aquatic Geochemistry, Paris, France; (2) Université Lille 1, Lille, France; (3) IPGP–SCP Univ. Paris Diderot, Geochemistry and cosmochemistry, Paris, France

Organic matter is an important factor that cannot be neglected when considering global carbon cycle. New data including organic matter geochemistry at the small watershed scale are needed to elaborate more constrained carbon cycle and climatic models. The objectives are to estimate the DOC and DIC yields exported from small tropical watersheds and to give strong constraints on the carbon hydrodynamic of these systems. To answer these questions, we have studied the geochemistry of eleven small watersheds around Basse-Terre volcanic Island in the French West Indies during different hydrological regimes from 2006 to 2008 (i.e. low water level versus floods). We propose a complete set of carbon measurements, including DIC and DIC concentrations, 13C data, and less commonly, some spectroscopic indicators of the nature of organic matter. The DOC/DIC ratio varies between 0.67 and 0.30 in low water level and between 0.07 and 0.30 in floods, indicating that organic matter is mainly exported during floods. On the light of the isotopic composition of DOC, ranging from 32.8 to 26.2 during low water level and from 30.1 to 27.2 during floods, we demonstrate that export of organic carbon is mainly controlled by perennial saprolite groundwater, except for flood events during which rivers are also strongly influenced by soil erosion. These annual yields vary from 2.5 to 5.7 t km2 year1 for the DOC and from 4.8 to 19.6 t km2 year1 for the DIC and exhibit a non-linear relationship with slopes of watersheds. The flashfloods explain around 60% of the annual DOC flux and between 25 and 45% of the DIC flux, highlighting the important role of these extreme meteorological events on global carbon export in small tropical volcanic islands. From a carbon mass balance point of view the exports of dissolved carbon from small volcanic islands are important should be included in global organic carbon budgets.

Modeling the 2013 Typhoon Haiyan storm surge: Effect of wave coupling, offshore winds, and tidal level

Ph. Bilgera (1); C. Villanoy, (1); O. Cabrera, (1)
(1) The Marine Science Institute, University of the Philippines, Diliman, Quezon City, Philippines
Super Typhoon Haiyan, with wind speeds exceeding 300 km h\(^{-1}\) generated a storm surge in San Pedro Bay reaching heights of more than 6 m in Tacloban City. Severe winds and storm surge heights caused catastrophic structural damage and casualties. Delft Dashboard (DDB), an open-source storm surge Matlab based graphical user interface, was used to develop a coupled flow and wave storm surge model to understand the Typhoon Haiyan storm surge development and propagation. Model results corroborated by obviou...
compound effect of increasing drought severity and increasing water demand is worrisome, especially for the most vulnerable populations.

This work quantifies and analyzes the evolution of drought during the instrumental period (back to the late 19th century) and under future climate projections from CMIP5 models. Drought is analyzed in terms of its characteristics (frequency, area, duration and severity) and the co-evolution of the forcings (precipitation and potential evaporation). The historical analysis is based on updated multi-model land surface simulations driven by a hybrid meteorological dataset that merges available satellite observations on rainfall and reanalyses. Drought is quantified based on anomalies in precipitation, soil moisture and streamflow, representing different aspects of drought: meteorological, agricultural and hydrological. There are considerable changes in long-term changes because of: uncertainties in changes in precipitation due to station sampling and errors in large-scale datasets (e.g. from satellites and reanalyses); uncertainties in changes in other less well observed surface meteorological variables such as humidity and windspeed, and in surface radiation that drive potential evaporation; and uncertainties among land surface models in how drought propagates from meteorological to soil moisture to hydrological drought. In particular, the uncertainties are highest in transitional to dry regions where the station density is generally lower and differences among land surface models becomes important.

Future projections of drought from CMIP5 models indicate a general propensity towards increased drought severity in many regions due to changes in precipitation seasonality and atmospheric demand. In some regions, such as the Mediterranean and southern Africa, the changes are set against a background of increasing aridity. However, the magnitude of these changes is highly dependent on the climate model in addition to the emissions scenario. We focus on the uncertainty in drought projections with respect to climate model ability to replicate the observational estimates of land–atmosphere coupling as derived from our ensemble of land surface models. Results indicate that the representation of coupling in the models, soil moisture, evapotranspiration, and temperature plays a role in the uncertainty in future projected changes in evapotranspiration with implications for changes in available water and drought.

P.1119-09
Change of vulnerability towards flooding in the commercial sector

H. Kreibich (1)
(1) German Research Centre for Geosciences, Section Hydrology, Potsdam, Germany

Flood risks emerge from extreme hydrological events and exposure of human activity. Various studies have analyzed past flood damage data for trends and tried to attribute it to specific drivers. A large part of the observed upward trend in damage is assumed to be related to socio-economic factors. Whereas changes in exposure are relatively well understood, there is hardly any knowledge about changes in susceptibility, particularly in respect to companies, which are quite heterogeneous but contribute a large share of damage.

Therefore, vulnerability data from companies affected by recent floods in Germany were analyzed to gain quantitative information about changes in susceptibility during the last decade and how these changes are linked to flood experience and other physical and social drivers.

Preliminary results reveal that in the case of a flood event, most companies undertake emergency measures. The effectiveness of these measures is increased by recent flood experience, emergency plans, reliable warning with longer lead times, and lower water levels. Additionally, larger companies that own their buildings seem to be more effective in undertaking emergency measures. Also, many companies undertake precautionary measures after a flood, but still much more could be done. Perhaps the diversity of responsibilities in businesses and the institutional structure create hurdles as well as the level of funding during extreme events are cost-effective and will provide significant damage reduction.

P.1119-10
Estimating extreme dry-spell risk in the Ichkeul basin northern Tunisia

M. Mathlouthi (1); F. Lebdi (2)
(1) Research Laboratory in Science and Technology of Water in INAT, National agronomic institute of Tunisia, Tunis, Tunisia; (2) National Agronomic Institute of Tunisia (INAT), Genie rural, eaux et forêts, Tunis, Tunisia

Drought is a natural phenomenon that can occur in all regions. Climate variability and change can influence the longer term consequences of economic, social and environmental. It is likely that climate change increases the frequency and duration of droughts, which could contribute to land degradation. One develops the event-based approach tailored to the sub–humid climatic conditions. A dry period is defined as a series of days with daily rainfall less than a given threshold. Unlike the dry period, a dry event may last only one day. Dry events are considered as a sequence of dry days separated by rainfall events from each other. Thus the rainy season is defined as a series of rainfall and subsequent dry events. Rainfall events are defined as the uninterrupted sequence of rainy days, when at last on one day more than a threshold amount of rainfall has been observed. The case study of Lake Ichkeul in north of Tunisia, at a Mediterranean climate, is used to illustrate the approach. One focuses on the evaluation of dry events in duration and frequency in the region under the influence of a changing climate. It identifies the longest dry and wet events on the history. For planning purposes, the longest dry spells associated with the various statistical recurrence periods are derived on the basis of the fitted GEV type probability distribution functions. The event–based analysis is used to calibrate the precipitation models with both rainfall and dry event records. The effects of climate change and to generate long synthetic rainfall event time series. The synthetic sequences of rainfall events and dry events are used to define and calibrate simulation models for realistic planning of reservoirs or for estimating water demand irrigation.

P.1119-11
Historical floods in North Algeria

M. Mohamed (1)
(1) Higher National School of Hydraulics, BLIDA, Algeria

The flood of 1974, which occurred in Kabylie and Algiers regions. This flood has produced 52 dead and 18000 victims and enormous material damage in Kabylie. The corresponding rates for this event are 2972 m^3/s (80-year return period) and 2940 m^3/s (130-year return period) at Algiers station; 2520 m^3/s (130 year return period) at Baghila, Belloua and Lakhdaria hydrometric stations respectively in the region of Kabylie. The disaster also affected Algiers. Floods in eastern Algiers, and in the Wilaya of the same name caused significant damage. At the Baraki station, a flow rate of 1620 m^3/s with a return period of 100 was raised. At the bottom of the Atlas Blidene, the station of the Roche des piégeons, a flow of 820 m^3/s with a return period of 40 was recorded. The floods were followed a rain event, recorded at mountain pass Skamody (Atlas overlooking the Mitidja East) for 620 mm (58% of the annual total) in four days and 310 mm (30% of the annual total) in one day with 32-year return period. It is noted that the return period of rain is not as important as the maximum flow rates recorded for this period. The city of Azzazza in the Kabyle was also the scene of a spectacular flash flood in October 1971. The disaster killed 40 people. The return period of the recorded flow was 20 years and generator rain of this flood was 182.6 mm in one day with 300 years return period. The recorded extreme floods, which caused many deaths and material losses, is due to the combination of the nature of rainfall and the relief of the region. The region is characterized by rugged terrain very favorable to flow and the rapid progression of the flood wave.

In western countries, the floods of Oued Rhiou, occurred in 1993, caused the death of 22 people. The maximum flow was 719 m^3/s with a return period of 17 years. In the same region, in 1965, major floods were recorded with 825 m^3/s at Oued Rhiou station and 809 m^3/s at Relizane with a 30-year return period. Also on the west of the country (region I), the floods of October 2000 caused 4 deaths. The maximum flow was 550 m^3/s with a return period of 80 years. The maximum rainfall recorded for this period was 85 mm with a return
A 2700 cal yr BP extreme flood event revealed by sediment accumulation in Amazon floodplains

P. Moreira-Turcq (1); B. Turcq (2); L. Silva Moreira (3); RC. Cordeiro (3); M. Amorim (3); JL. Guyot (4)

1. Institut de Recherche pour le Développement, CET, Lima, Peru
2. Institut de Recherche pour le Développement, LOCEAN, Lima, Peru
3. Universidad Federal Fluminense, Departamento de geoquímica, Niterói, Brazil, (4) IRD, Lima, Peru

Climatic conditions are one of the most important factors affecting sedimentation processes in Amazon floodplains. Connected lakes can be directly related to hydrological patterns of the Amazon River mainstream. In this context, we analyzed five sediment cores taken in two floodplain systems situated in the lower Amazon River, to investigate sediment accumulation patterns during the Holocene. Our records show abrupt fluctuations in sedimentation rates in lakes that can reach more than 2 cm/yr during some periods. We find that in all cores, sediment stratigraphy is characterized by packages of sediments of uniform age, which are typically 10–80 cm thick and present a variegated color. The 14C age of the upper package is about 2700 cal yr BP. During this abrupt event, sediment accumulation rates in floodplain lakes can be at least 200 times higher than those of “normal” periods. This sedimentation event is interpreted as being the consequence of one or several successive extreme floods. The 2700 cal yr BP event has been also observed in other regions in South America and other regions in the world, although different impacts can be observed in each system. This event probably corresponds to a conjunction of favorable conditions for extreme Amazon discharge associated with the Middle to Late Holocene increase of astral summer insolation and shifts of the Intertropical Convergence Zone (ITCZ) from northern to southern positions. In this context, a marked negative peak in solar irradiance at 2700 cal yr BP seems to have provoked cooling on the continents and a southward shift of the ITCZ associated with a probable reduction in Atlantic Meridional Overturning Circulation.

Critical erosion rates in mountain catchments during catastrophic events El Niño: from the west central Andes to the Pacific Ocean (Peru)

SB. Morera Julca (1); A. Crave (2); JL. Guyot (3); A. Desiderio, (4); O. Grover, (5); S. Vilcabana, (6); C. Gálvez, (7); T. Condom (8)

1. Odessa State Environmental University, Odessa, Ukraine
2. Instituto de Investigaciones del Perú (IIAP), Lima, Peru
3. Universidade Federal Fluminense, Departamento de geoquímica, Niterói, Brazil, (4) IRD, Lima, Peru
4. Center for atmospheric research (nCar, USA)
5. Instituto de Investigaciones del Perú (IIAP), Lima, Peru
6. Universidad Abierta de las Américas, Lima, Peru
7. Université Paris 6, CNRS, École Normale Supérieure, Paris, France
8. IRD, Lith, Grenoble, France

Erosion rates and sediment flux from the Andes to the coast of Peru, is largely unknown. The aims of this study is to bridge the knowledge gap by quantifying and understanding the magnitude and signal frequency of sediment fluxes from the west central Andes mountains to the Pacific coast. A new extensive suspended sediment yield (SSY) database from short to long-term erosion periods is collected (1948–2012). Measurements were taken at 101 stations (for the precipitation) were obtained relevant values (eg, annual precipitation) and calculated values - the data different models. In order to obtain predictive values of temperature and rainfall in the plains of Ukraine, the data were obtained relevant dependencies that have high correlation coefficients, indicating the possibility of reducing the adverse effect of climate change on flood runoff. The simulation results are presented in the form of the coefficients of runoff change. The value of the coefficient of runoff changes taken equal to 1.0 for all the scenarios, except for the scenario (A1B, B1, A2) give more or less similar results – no significant decrease in runoff spring flood in northern areas, and significant – in the southern. Conversely scenarios COMMIT and CCSM3 predict a decrease in spring flood on rivers in zone of sufficient moisture (basins of Western Bug, Pripyat, Desna, Dnieper) by 10–20%, and on the rivers in the zone insufficient moisture (basins of Southern Bug and Southern Donets) by 20%–40%. As for Azov region rivers, for them, as well as in other scenarios expected to reduce runoff spring flood more than 50%. Analyzing the forecasting period from 2069 to 2099, it should be noted that the results differ significantly for different scenarios. So scenarios A1B and A2 on 2099 are predicting practically disappearance spring flood (water content decrease from 100 to 80%) on the rivers zone insufficient moisture, and to areas of sufficient moisture – reducing runoff by more than 50%. Slightly different results provide scenarios B1 and COMMIT. The scenario B1 for the period up to 2069 is predicting a slight increase in water resources of spring flood (from 20% to 50%), excepting to rivers Azov region, and on the period up to 2099 - a slight increase in the relative to 2069 for the rivers in area of sufficient moisture and stabilization – for rivers in area insufficient moisture - so scenarios are not fully understood, further studies on this topic are conducted.
Extreme Hydrological Events, Vulnerability and Coping Mechanism for Sustainable Livelihood in Alaknanda River, Basin, Uttarakhand

BW. Pandey (1)
(1) University of Delhi, Department of Geography, Delhi, India

Extreme events are sudden calamities, which involve loss of life, property and livelihood. This paper presents a methodological approach for the integration of extreme events, climatic vulnerability, land use scenario modeling and flood risk assessment. Alaknanda river basin is located in the eastern part of the Garhwal Himalaya and represents one of the most acutely hazard–prone regions in the country. The important factor causing flood and also accelerate several hydrological hazards during monsoon periods in Alaknanda river are heavy rainfall, cloud burst, GLOF, landslides, Slope failure, earthquakes, deforestation, poor drainage due to urbanisation. These hydrological hazards are mainly responsible for several socioeconomic consequences (cultivated land degradation, infrastructure loss, human casualties, loss of transmission lines, and so on) in the Alaknanda river basin, Uttarakhand. Primary data from each hotspot has been collected through a questionnaire survey and a Participatory Research Approach (PRA) procedure that is based on the LIFE approach. The LIFE Approach is based on Livelihood options, Institutional participation in adaptation on policy design and implementation, Food security and Empowerment parameters like health and education. These parameters are important in building resilience capacity and ensuring sustainable development pathways of water resources, i.e., till 2099 coefficient of change of almost all rivers except the Azov region, is 1.0. As for the script COMMIT, there is projected to increase runoff of spring flood from 1.75 to 3.5 times by 2069.

Hydrological extremes, food security and agriculture in western Amazon

J. Ronchail (1); T. Schor (2); M. Sabot (3); J.C. Espinoza (4); N. Filizola (5); G. Drapeau (6); JL. Guyot (7); JM. Martinez Cordeiro (4); S. Caquineau (5)
(1) Universidade Federal Fluminense, Departamento de geoquimica, Niterói, Rio de Janeiro, Brazil; (2) Instituto de Geofisico del Peru, Lima, Peru; (3) Instituto de pesquisa para a Conservação de fauna e flora do Amazonas, Manaus, Brazil; (4) Instituto Geofisico del Peru, Lima, Peru; (5) Institut de recherche pour le Développement, Get, Lima, Peru; (6) Laboratoire de géodynamiques, hydrologie et observatoire SO-HyBAM (Geodynamical, hydrological and biogeochemical control of erosion/alteration and material transport in the Amazon basin).

A mineralogical and organic geochemical overview of the effects of Holocene changes in Amazon River flow on three floodplain lakes

L. Silva Moreira (1); P. Moreira-Turcq (2); B. Turcq (3); RC. Cordeiro (4); S. Caquineau (5)
(1) Universidade Federal Fluminense, Departamento de geoquimica, Niterói, Rio de Janeiro, Brazil; (2) Institut de recherche pour le Développement, Get, Lima, Peru; (3) Institut de recherche pour le Développement, Lima, Peru; (4) Universidade Federal Fluminense, Departamento de geoquimica, Niterói, Brazil; (5) Institut de recherche pour le Développement, Bondy, France

A synthesis of the impacts of the Amazon River hydrological changes on the sedimentation process of organic matter (OM) in three different floodplain lakes (Santa Nina, Maraca, and Comprido lakes) is presented in this study. Today the Santa Ninha and Maraca lakes are directly and permanently connected with the main channel of the Amazon River, in contrast to Comprido Lake, which is indirectly and periodically influenced by the Amazon River due to its greater distance from the main channel. All three lake sediment records showed a reduced river inflow due to dry climatic conditions during the early and middle Holocene followed by an increased river inflow in the wetter late Holocene. In Santa Ninha and Maraca Lakes, the reduced river inflow period was recorded by sediments with a low abundance of smectite (on average ~20 wt.%), a clay mineral mainly transported by the fluvial system, and high total organic carbon (TOC) contents (on average ~8.2 wt.%). During the late Holocene, a higher smectite abundance (on average ~43 wt.%) and a lower TOC content (on average ~1.4 wt.%) pointed to greater dilution by riverine lithogenic matter. This change was accompanied by the increase in aquatic primary productivity, as shown by the increased $13^C$ values and by a C/N typical of algae, suggesting a higher lake water level. In Comprido Lake, a sedimentation gap occurred during the early and middle Holocene. The wetter late Holocene, from 3000 cal years BP onwards, a gradual increase of the TOC and high derivatives and Aulacoseira sp. suggest an increase in the productivity and in water level due to the high water flow of the Amazon River and the catchment area as well. Consequently, our study shows that the sedimentation processes of organic matter in Amazonian floodplain lakes were strongly influenced by variations in the hydrodynamic regime of the Amazon River during the Holocene. However, the impacts of the various climatic scenarios were different depending on the distance of each lake from the main channel of the Amazon River.
Run-off events registered in East Pacific equatorial region during the late Holocene: analysis of possible causes through IPSL model transient simulation

B. Turcq (1); O. Marti, (2); P. Braconnot (2); M. Saint-Lu, (2); J. Leloup, (3); D. Gutierrez Aguilar (4)

(1) Institut de Recherche pour le Développement, Lecanoe-ipsl/upch, Lima, Peru; (2) LSCE–IPSL, Gif–sur–Yvette, France; (3) LOCEAN – IPSL, Paris, France; (4) Instituto del Mar del Perú, IMARPE, Dirección General de Investigaciones en Oceanografía y Cambio Climático, Callao, Peru

An increase of elastic sediment inputs has been observed between 5 and 4 kyrs BP in lakes of the equatorial region of South America, in Ecuador and Galapagos islands as well as in marine sediments off Northern Peru. These changes in sedimentation have been interpreted as a strengthening of El Niño due to insolation change. Conversely, data from central and west-Pacific corals do not indicate a clear trend of ENSO change during the Holocene but strong centennial to millennial oscillations.

To help interpreting the climate change in this region we analyzed a transient simulation of IPSL CM5A LR global climate model from 6 to 3 kyrs BP. The simulation indicates an increase of heavy rainfall events (monthly rainfall intensity) in the East Pacific (90°-80°W, 0°-6°S) since 5 kyrs. Most of these events are linked to occurrences of El Niño events and the summer precipitations show a multi-decadal variability related with the variability of SST anomalies in El Niño 3–4 region.

However the model did not show important change in SST anomalies in ENSO 3.4 or ENSO 1+2 regions during this period although there is a 0.2°C increase of SST between 6 and 5 kyrs. The comparison between 6 and 4 kyrs precipitation maps show that the main difference is a northern shift of ITCZ position during South Hemisphere summer that provokes more intense rainfall in the study region. This northern shift is also observed on the Atlantic Ocean in agreement with paleoclimatic data from lakes and speleothems in Northeast Brazil. In conclusion the IPSL transient simulation suggest that the impact of El Niño events in term of precipitation in the East Pacific can have been modulated by shift of the ITCZ during the Holocene.

This study is supported by ANR El Paso n° 2010 BLAN 608 01 and by the french national programme LEFE/INSU.

Changes in extreme hydrological events in highly regulated river basins of Catalonia (NE Spain): discerning between climate change processes, land cover modifications and water resources management

P. Kinney (1)

(1) Columbia University, Mailman School of Public Health, Climate and Health Program, New York, NY, United States of America

Air quality is a major modifiable health burden around the world, especially in rapidly developing cities. Exposure to air pollution, including fine particles (PM2.5) and ozone, has adverse effects on human health throughout the lifespan. Adverse effects of air pollution include the development of chronic diseases such as lung cancer, chronic heart and lung diseases, as well as adverse effects on the reproductive system and on neuro-development. Action to mitigate air pollution brings immediate and lasting benefits for the health and well-being of the population. In addition, well-designed air pollution mitigation actions have the potential to reduce severe impacts on the climate system. In order to inform global, regional and urban scale air pollution and climate planning, there is a need for multi-scale health impact assessments that estimate the potential health impacts and/or benefits that may result from reducing air pollution.

We describe several such recent and/or ongoing efforts of this kind. For example, the recently-completed AC-Health project estimated the influence that reducing air pollution emissions could have on global, regional and urban public health in 2030 and 2050, compared to 2010, taking into account the influence of climate change. The Air pollution and Climate Change Impact Assessment: Estimation of the Human Health Benefits project assessed the possible impacts of future climate change and alternative air pollution mitigation scenarios. Assessments were carried out across three different geographic scales with increasing spatial.
granularity, for the entire world, for Europe, and for the Paris metropolitan region. Two mitigation scenarios were evaluated: a business as usual scenario based on national regulations already on the books, and a maximum feasible reduction scenarios based on available technologies for air pollution control. The results showed the potential for substantial increases in global deaths due to PM2.5 and ozone under the business as usual scenarios, especially in south and east Asia. On the other hand, substantial health benefits could be achieved under a maximum feasible reduction scenario. In general, health assessments carried out at finer spatial scales yielded greater health benefit estimates. This and other studies are pointing the way to a new generation of tools for integrated air quality and climate planning.

Enormous health benefits can be achieved from well-chosen climate mitigation strategies that simultaneously reduce air pollution concentrations in the local and regional environments in which the emission reductions occur. However, to evaluate those benefits in relation to specific mitigation options, careful analyses are needed at appropriate spatial scales to link the air pollution reductions to locations of vulnerable populations. Through such analyses, alternative mitigation strategies can be compared and prioritized based on their potential health benefits, providing critical input to decision makers.

O-1121-01
Public health response to climate change in twenty-two European countries

B. Menne (1) ; V. Kendrovski, (2) ; T. Wolf (3) ; S. Gerardo (2) ; J. Creswick (3)
(1) WHO, Program manager, climate change and sustainable development, WHO, ECEE, Bonn, Germany; (2) WHO, Bonn, Germany; (3) Cgs, Bonn, Germany

Introduction: WHO European Member States (53 countries) agreed on implementing the European Framework for action on climate change and health. One of the mandate is the assessment of health implications of climate change and the development of national health adaptation plans, as a contribution to WHO and UNFCCC developments.

Scope: to assess the scale and content of the national adaptation plans and the assessments, to identify incremental, transitional and transformational approaches and to guide future political and scientific developments

Result: Between 2000 and 2014, twenty-two WHO European Member States, developed national adaptation plans with a health component; while 32 European Member states, developed national adaptation plans and the assessments, to identify climate adaptation plans and the assessments, to identify the need for health benefitting mitigation measures against air pollution. The total cost of mitigation (air and climate) remains however higher under the maximum feasible mitigation than under the business as usual pathway.

The analysis of air and climate modelling results within a monetised health impact assessment framework allowed assessing expected sanitary benefits. It is important to highlight that the expected monetised sanitary benefits compensate the costs of climate mitigation, showing that air quality can be considered as a positive externality of low carbon policies.

O-1121-03
Global and European scale health impact assessment (HIA) of PM2.5 over the 21st century

V. Likhvar (1)
(1) CNRS, Paris, France

Multi-scale approach to health impact assessment (HIA) can illustrate the difference in direct consequences of costly mitigation policies. Although this approach provides results that may help decision-makers choose between different policy alternatives at different scales, it has several limitations, such as the choice of concentration-response function (CRF). The recently developed integrated exposure-response (IER) model (Burnett et al. 2014) combines global relative risk information from different combustion types of PM emissions, and can describe exposure-response relationships between PM2.5 and leading global causes of death, such as ischemic heart disease (IHD), cerebrovascular disease (stroke), chronic obstructive pulmonary disease (COPD), and lung cancer (LC). Using this model and ECLIPSE air pollution scenarios (current legislation (CLE) and maximum feasible (MFR), we estimated future impact of PM2.5 on health at global and European scales in 2030 and 2050. Our preliminary results showed that 1/3 of total global burden of ambient air pollution on IHD deaths is associated with PM2.5 (488 000 deaths/year). If maximum reduction measures are implemented by 2030, this should be reduced globally by 17%; on the other hand, with the current legislation scenario the number of IHD deaths should continue to increase, and by 2030 it will reach 586 000 deaths annually.

However, these results may be greatly underestimated, as the PM concentration levels produced by the global model were much lower compared to the regional scale estimates.

O-1121-02
The impact of climate policies on European air quality in the 21st century

A. Colette (1) ; S. Schucht, (1) ; B. Bessagnet, (1) ; M. Holland, (2) ; Z. Klimont, (3) ; L. Menut, (4) ; S. Rao, (3) ; S. Szopa, (5) ; R. Vautard (6) ; J. Brignon, (1) ; L. Rouil, (1)
(1) INERIS, Verneuil-en-Halatte, France; (2) EMRC, London, United Kingdom; (3) IIASA, Laxenburg, Austria; (4) IPSL, Palaisseau, France; (5) IPSL, Saclay, France; (6) Laboratoire des Sciences du Climat et de l’Environnement, Saclay, France

Climate change, long range transport of pollutants and surface air quality share multiple interaction pathways. Tailoring efficient air quality mitigation strategies over the long term requires taking into account such external factors whose variability can be neglected for short term projections. We designed, developed and implemented a new regional air quality and climate modelling system to account for the possible penalties of climate change and long range transport of pollutants on European air quality. In order to ensure its relevance for environmental policy making, this modelling system is embedded in a quantitative cost–benefit analysis framework.

The regional air quality and climate modelling suite allowed proposing an assessment of European air quality in 2050. We highlighted the dominating influence of mitigation of anthropogenic emissions of pollutants in Europe. But the penalty brought about by climate change on ozone pollution was also confirmed, and the large impact of long range transport at the 2050 horizon was emphasized. For particulate matter, long range transport is less important; the impact of climate change is significant but also uncertain.

Thanks to the use of air pollutant emission projections based on emission factors reflecting the current legislation, we could assess the costs of climate mitigation and air quality legislation. We point out the economic benefit of climate policies for air quality legislation due to a low carbon economy requiring less end-of-pipe technological measures against air pollution. The total cost of mitigation (air and climate) represents the penalty brought about by climate change on ozone pollution was also confirmed, and the large impact of long range transport at the 2050 horizon was emphasized. For particulate matter, long range transport is less important; the impact of climate change is significant but also uncertain.

The analysis of air and climate modelling results within a monetised health impact assessment framework allowed assessing expected sanitary benefits. It is important to highlight that the expected monetised sanitary benefits compensate the costs of climate mitigation, showing that air quality can be considered as a positive externality of low carbon policies.
O-1121-04
Evaluating air quality impact on mortality and crop yields in South Asia
S. Ghude (1); C. Jena (1); D. Chate (1); G. Beig (1)
(1) Indian Institute of Tropical Meteorology, Pune, India

Climage change has been shown to increase surface O3 in many regions of the world and have raised concerns about the O3 impact on mortality and the magnitude of yield reductions, primarily occurring in the developing nations.

Demographically agriculture is the broadest economic sector, rank worldwide second in farm output and principle source of livelihood for more than 58% of 1.2 billion people. ragweed plays an important role in the overall socio-economic fabric of India. We have quantified, for the first time, a district–wise impact of surface ozone on cotton, soybeans, and rice and wheat crops for all of India. On a national scale, we estimate fractional relative yield loss for wheat of about 5.0 (±1.2) %, 2.1 (±0.9) % for rice, 5.3 (±3.1) % for cotton and 2.7 (±1.9) % for Soyabeans, with the losses concentrated in central and the Indo–gaṅgetic plains of north India. In terms of absolute production loss, by wheat, is the most impacted crop, with losses of 3.5±0.8 Mt followed by rice (2.1±0.8 Mt) sufficient to feed 94 million people living below poverty line in India. To estimate crop production losses into national economic damage, we estimate an economic impact of 1.29±0.47 billion USD. Sensitivity studies with the integrated model study reveals NOx as the key pollutant causing as much as 93% of the crop loss.

Significant portion of human population in India is believed to be regularly exposed to higher surface ozone (O3) levels. Health has been linked to total, cardiovascular and respiratory mortalities and hospitalizations (COPD) caused by population exposure to surface O3. Attributable mortalities are quantified using health impact function of lead term related risk (attributable risk proportion) for O3 from epidemiology literature. We calculated total mortality of about 1125 thousands, 404 thousand cardiovascular and 376 thousand deaths by respiratory diseases, and COPD cases of about 175 thousands caused by O3 exposure to population of India in 2005. The highest number of total, cardiovascular and respiratory mortalities and COPD cases are found in the highly populated Indo-Gangetic region followed by metros, cities and sub–urban and industrial areas.

O-1121-05
Impacts of Climate change and seed dispersal on airborne ragweed pollen concentrations in Europe
L. Hamaoui-Laguel (1); R. Vautard (2); L. Liu (3); F. Salom (3); N. Viovy (2); D. Khvorostyanov (4); F. Essl (5); I. Chuine (6); A. Colette (7); L. Lherminier (7); L. Hamaoui-Laguel (1); R. Vautard (2); L. Liu (3); F. Solmon (3)
(1) Institut National de l’Environnement Industriel et des Risques, Verneuil–en–Halatte, France; (2) Laboratoire des Sciences du Climat et de l’Environnement, Saclay, France; (3) International Centre for Theoretical Physics, Trieste, Italy; (4) Laboratoire de Météorologie Dynamique, CNRS, Palaiseau, France; (5) University of Vienna, Vienna, Austria; (6) Centre d’Ecologie Fonctionnelle et Evolutive, CNRS, Montpellier, France; (7) Rothamsted Research, Harpenden, United Kingdom; (8) Medical University of Vienna, Vienna, Austria

Common ragweed (Ambrosia artemisiifolia) is an invasive weed native to North America producing very allergenic pollen which causes serious health effects like rhinitis, asthma and atopic dermatitis. It was introduced in Europe since the mid–19th century and invaded large areas during the last few decades (Pannonian plain, Northern Italy and South–Eastern France). Furthermore, there is a high potential for ragweed spread in current suitable habitats and future changes in climate and land use may increase this trend. The climate–related–climate niche determined by physiological thresholds or affecting cropping patterns. The rate of spread depends also on seed dispersal due to natural or anthropogenic processes and the efficiency of ragweed eradication policies. However, ragweed airborne pollen concentrations depend not only on plant infestation, but also on phenology, pollen production, release, dispersion and atmospheric transport.

Here, we present the first integrated modelling framework, based on an explicit representation of plant phenology, pollen production, and release to the atmosphere, to assess future changes in airborne pollen concentration under scenarios of climate and land use changes and seed dispersal. Two model suites are implemented differing in the atmospheric dispersion module and the driving climate models. The CHIMERE suite uses the Chemistry-Transport Model CHIMERE model, forced by regional climate simulations from the WRF model downsampling of the IPSL-CM5A-MR model. The RegCM4 regional climate model forced by global climate simulations from HadGEM CMIP5.

We performed three types of simulations (50 km grid covering Europe), which are hind–cast (2000–2012), historical (1986–2005) and future (2041–2060) simulations. The hindcast simulations, forced by ERA–Interim reanalyses, are used to determine the Henri’s chain. The historical simulations are carried out using calibrated ragweed density to serve as a reference simulation for the future. We considered two contrasting RCPs (Representative Concentration Pathways) climate change scenarios including a high–end (RCP 8.5) and moderate (RCP 4.5) climate change scenarios and three seed dispersal scenarios (reference, slow and rapid).

We show that airborne pollen concentrations may drastically increase in 2050 by a factor of 4.5 under high–end RCP 8.5 and 4.1 under RCP 4.5 under climate change scenarios. This upsurge is largely dependent on the seed dispersal rate, making this increase vary in a range of factors from 2 to 12 according to the range of flowered assumed. We estimate that third of the projected increases of pollen concentration are due to the on–going seed dispersal within the present niche regardless of climate change. Climate change will be responsible of two thirds of the future pollen loads increase. It will extend the habitat suitability for ragweed in Northern and Eastern Europe and result in higher pollen concentrations in established ragweed areas mostly due to a larger primary production with increasing CO2. Therefore, future increase of airborne pollen concentrations will be caused by the combined effects of climate change and ragweed seed dispersal in current and future suitable areas.

Our results indicate that controlling the current European ragweed invasion will become more difficult in the future as the environment will be more favourable for ragweed growth and spread, highlighting the need for the development of effective and regionally co–ordinated eradication programmes.

P-1121-01
The Air Quality Improvement by Precipitation during the Spring Season
Sh. Ahn (1); SW. Lee (1); JY. Kim (1); CH. Park (1)
(1) National Institute of Meteorological Research (NIMR), Research Planning and Management Division, Seogwipo–si, Jeju–do, Republic of Korea

Meteorological elements determining air quality are significant, given that many premature deaths each year are attributed to air pollution. The washout effect of precipitation on air pollutants is of particular importance, since every spring yellow dust and high level of particulate matter (PM) in the Korean Peninsula has reduced visibility and threatened the health of the people. The air pollutant is a substance in solid, liquid or gaseous form in the air, which is caused by natural action and human activities. Air pollution is a serious problem that threatens the health of the people, inflicts harm to plants and forest, and has toxic effects to the environment. These air pollutants are removed from the air by wet deposition process referring to precipitation, fog, and condensation. This study has analyzed air quality improvement by precipitation during the period from 2009 to 2013, we selected 56 cases that were accompanied by snowfall, and the precipitation data from the Korea Meteorological Administration (KMA). We calculated the difference of air pollutant concentration during the
a specific index of pollution from motor vehicle traffic. In fact, these measures become very relevant for the protection of the health of the population for the high permanence of carbon particles in the atmosphere and the many chemical and physical processes of transformation that they may undergo in the atmosphere.

The good correlation between the values of OC and EC shows that the area of the historic center of Rome the most important source of atmospheric carbon is in the motor vehicle traffic, ie an element typically anthropic, as indeed in the main industrial area source is the combustion. instead different situation is found in a remote area, where this correlation is reversed from the point of view of quality and is. decidisamente lower by quantitatively indicating the presence of natural sources.

the separation between EC, of primary origin, and OC, the source primary and secondary, is of fundamental importance for the study of the effects of photochemical aerosol, particularly generally, for the toxic effects and for the study of the mechanisms of formation of photochemical pollutants. it follows that, on a microscale, the carbon becomes more important for human health than other natural environmental factors.

You can make a first distinction between risk and risk widespread local anthropogenic natural: However, the loss of ten. To increase rapidly, as evidenced by all the curves and the time series presented recently by several authors.

The anthropogenic component becomes more important and fundamental as to require choices and impose serious and important related to the lifestyle of the population.

Finally, in this horizon quite accurate plus future situations by having to still monitor: the conversion of coal, for example, of new industries are not yet known, especially how it affects the territory locale.in any case, new energy technologies, definitely interesting for the greater energy yield, should be evaluated from the point of view of environmental compatibility.

**P-1121-04**

**Evaluation of the Spatial Relationship between Air Pollution and Respiratory Infections in Meknes City, Morocco**

I. Boularab (1) ; O. Mouhaddach (1) ; MP. Kestemont (2) ; S. El Jaafari (1)

(1) Moulay Ismail University, Meknes, Morocco; (2) Catholic University of Louvain, Louvain-la-Neuve, Belgium

**Background:** With 3.7 million precipitation days in 2012, the World Health Organization indicates that air pollution is a major environmental risk. In Morocco, 41% of the morbidity associated to respiratory infections due to air pollution. Despite this health risk clearly linked to air pollution, there are few studies conducted in relation to air pollution- health in Meknes, the capital of the Meknes- Tafilalet region.

The analyses of geographical distribution of respiratory infections in Meknes city, as well as the study of its relation to potential environmental risk factors, have an important role to develop an efficient system for the monitoring and prevention of this type of diseases.

**Methods & Results:** The present study aims to elucidate the relationship between air pollutants in the Meknes city and the spatial distribution of respiratory consultations as health indicator. First, we present an overview of the mobile and stationary sources of air pollution in the city, with measurements of key pollutants. What helped to reveal that Meknes city suffers from air pollution by diverse sources and characterized by spatial and seasonal variability.

Next, we analyze the epidemiological situation of the health indicator, depending on the age and time, and the spatial distribution of their accumulated incidence compared to sources positions. It follows that the number of new consultations is disclose specially in the Autumn-Winter period and between persons less than 15 years. This variability also observed in space distribution, with a net increase in neighborhoods in the vicinity of sources of air pollution, particularly those situated in the wind direction promoting the flow of pollutants.
Climate and risk of vector borne zoonotic disease emergence: examples of Rift Valley and West Nile fevers

V. Chevalier (1); A. Tran (2)
(1) CIRAD, Montpellier, France; (2) CIRAD, Es, Montpellier, France

Vector borne diseases have a major impact on human and animal health, but also on society economy. Due to their transmission routes, zoonotic or not, these diseases are very sensitive to climatic changes. Actors, conditions and processes requested for disease transmission are part of a complex and dynamic system whose behavior, influenced by climate but also by other environmental and socio-economic components, drive potential for pathogen transmission in urban or rural areas. In this regard, climate and ecological disruptions induced by climatic variations, but also by landscape transformation by human or socio-economic disturbances, are the main component of disease emergence. The understanding of mechanisms and conditions that underlie these processes is part of the major challenges that scientist and health policy makers will have to face to in the coming years.

P-1121-06

Low cost portable sensors for measuring traffic related air pollution in tunnel

A. Gorin (1); S. Srairi (1); D. Guichon (1)
(1) CEREMA, Mobility department, Trappes en Yvelines, France

Air quality monitoring in tunnel has relied traditionally on static measurement stations. However these are expensive methods to capture pollution heterogeneities and identify pollution hotspots. In recent years, the development of portable sensing technology has attracted considerable interest because of the possibility to reduce operating cost of air pollution monitoring.

Despite this, there are few examples in the published literature of pollution measurement using portable sensors in tunnel. In this work, low cost portable sensors are used to measure traffic related air pollution in tunnel within the framework of the research operation SERRES. The objective of this research operation is to produce recommendations and solutions to limit the impact of road traffic on the environment. Within this research operation, low cost pollution portable sensors are characterized and air pollution measurement are correlated with the traffic data of the tunnel.

The present project was divided into four phases. Phase one was the characterization of the portable pollution sensors. A full set of preliminary tests was realised in laboratory to evaluate the portable sensor reliability and to analyze its performances in terms of accuracy, autonomy and memory capacity. Based on this preliminary tests, two sensors were chosen for their performances: Observ’Air sensor and Cairsens sensor. In phase two, the portable sensors were fixed to a static SIREDO measurement station close to a road. The two sensors were installed for 24 hours. The traffic data recorded by the SIREDO station were used to analyze the link between traffic condition and air pollution. A correlation between the road traffic condition and the evolution of the air pollution was verified. Phase three was the selection and the instrumentation of a tunnel. The Guy Môquet tunnel was selected as an experimentation site because it had the following characteristics: easy instrumentation, simple access and close to a static measurement station (SIREDO).

The tunnel is located in the Val-de-Marne district of south-east Paris. An instrumentation was realized inside the tunnel in collaboration with the Ile de France territorial division unit in charge of air quality. It involved placing and instrumenting four pollution portable sensors inside the tunnel. In phase four, experimental measurements were conducted and studied. A spatiotemporal analysis was made. The measures given by the portable sensors were compared to the results given by the static measurement station. A link between pollutant concentrations and road traffic condition was demonstrated.

Aknowledgment

This works is supported by the Technical Division for Territorial Development and Urban Planning of the CEREMA.

P-1121-07

Seasonal pattern of the associations between daily mortality and PM10 in Korea and Japan

H. Kim (1); Y. Honda (2); EK. Satbyul (1)
(1) Seoul National University, School of Public Health, SEOUL, Republic of Korea; (2) University of Tsukuba, 3Faculty of health and sport sciences, Tsukuba, Ibaraki, Japan

Background/Aims: Many studies have shown that particulate air pollution exposures are associated with increased mortality. However, only a few studies in Asian countries have examined the modification effects by seasons on air pollution–mortality associations. The aim

Also transmitted by mosquitoes, mostly from Culex genus, West Nile fever (WNV) is caused by a Flavivirus. Reservoir hosts are wild birds, mostly passerines. Human and horses are dead-end hosts. Introduced in New-World in 1999, the virus spread throughout the USA in few years. It is now endemic and transmitted till South of Argentina. Between 1999 and 2010, nearly 1.8 million people were infected; more than 100 000 neurological cases were recorded, from which 1308 were fatal (Kilpatrick 2011). In Europe, the virus has been recorded in the Mediterranean Basin since the sixties without any human or animal health consequences. However, in 2006 and 2007, human and equine neurological cases suddenly increased, in particular since 2010. Two recent studies showed that an above normal temperature during the preceding months of outbreaks was strongly linked to the high temperatures this hot summer added to the vector competency of mosquitoes and provokes an increase of the mosquito population densities (Tran, Sudre et al. 2014).

Ecological disruptions induced by climatic variations, but
of this study was to examine the air pollution–mortality associations within seasons in 13 cities, 6 cities from Japan and 7 cities from Korea, with four distinct seasons.

Methods: We applied stratified time–series models to the data sets in order to examine whether the effects of particulate matter less than 10μm in aerodynamic diameter (PM10) on mortality was modified by four seasons, spring, summer, fall and winter. The effect of PM10 on daily mortality was first quantified within seasons at each location with a time–series model, and the estimates were then pooled through a random–effects meta–analysis using the maximum likelihood method.

Results: The daily means of PM10 in S. Korea were 69.98 μg/m³ for spring, 45.89 μg/m³ for summer, 48.80 μg/m³ for fall, and 56.94 μg/m³ for winter. Every 10 μg/m³ increase in PM10 daily means were associated with an increase in non–accidental mortality of 0.17% (95% confidence interval [CI]: 0.05 to 0.29%) for spring, 0.44% (95% CI: 0.18 to 0.70%) for summer, 0.35% (95% CI: 0.13 to 0.55%) for fall and 0.14% (95% CI: 0.06 to 0.33%) for winter for S. Korea. For Japan, the spring, summer, fall and winter daily PM10 means were 33.96 μg/m³, 35.43 μg/m³, 31.99 μg/m³, and 30.7 μg/m³, respectively. The laboratory of public health Ministry of health at michoacan state, Morelia, Mexico; (6) Ministry of Health, Ministry of health at michoacan state, Morelia, Mexico. (6) Ministry of Health, Ministry of Health at michoacan state, Morelia, Mexico.

Objective: To show the epidemiological reports of the impact of air pollution and climate change in Michoacan State, Mexico since 2009 to 2013.

Results: Acute infectious diseases were identified like A/H1N1 flu virus and ozone air pollutant in april and may in 2009. Respiratory and diarrhoic infectious outbreaks in may 2010 and february 2010 in the Monarch butterfly biosphere region in East Michoacan. In the same year, in april an outbreak of viroli parahaemolyticus were presented. And, recently in 2013 a serial reports related with a low level pH decrease in the Pacific ocean coast and the presence of enterococcus were measured. All these results were associated with temperature, precipitations and climate change scenarios since 1950–2000 and 2020, 2030 and 2050 measures in Michoacan.

Main Conclusions: Acute and infectious diseases were identified in places where our global and local health and precipitations are increasing like world reports in ar4 and ar5 IPCC and others epidemiological data have been publishing.

P-1121-09

Pollen as a health indicator of climate change
S. Monnier (1); M. Thibaudon (1); J.P. Besancenot (1); N. Michelot (2)

(1) RNSA, Brussel, France; (2) MEDDE, Paris, France.

Climate change, which is now scientifically proven and well known to influence all field of life, has unavoidable consequences on pollen. There are still a lot of uncertainties about the changes affecting pollenization, but it is not disputed that the prevalence of allergies is on the rise for a number of reasons. The prevalence and severity of allergic symptoms does seem to be related to climate variations. Indeed, it certainly appears that a warmer climate (both observed in the past and projected into the future) leads to more pollen grains in the air, to earlier flowering and pollination dates, to longer pollen seasons and to poleward and upward shifts in ranges in plant species. Most of the observed increase in pollen densities in atmosphere is due to climatic changes. Air pollutant, ozone and NO2 can also irritate airways and the increased airway responsiveness is able to reinforce the effects of pollen allergy.

Objective: To show the association between climate change and seasonal and inter-annual variations in climate in six cities with different climates in Europe and classification of climate change indicators.

Methods: We applied stratified time-series models to the data sets in order to examine whether the effects of climate change on human health. The results obtained from birch pollen data (high allergenic potential throughout Europe and sensitivity to long-term climate events) of six cities with different climates in metropolitan France, show an increasing trend in pollen concentrations and, finally, in the number of allergy sufferers.

Conclusion: The results showed that the effects of ambient air pollution on acute mortality differed within seasons and by location. Further findings may provide information to agencies for protecting local populations from adverse health effects of air pollution.

P-1121-08

Climate Change Epidemiological Health Reports in Michoacan State, Mexico since 2009 to 2013
A. Molina-García (1); C. Armendariz-Arnez (2); L. Pacheco-Magaña. (2); G. Figueroa-Aguilar. (3); L.A. Saavedra-Romero. (3); E. Oñez. (3); J.M. Canela. (3) ; J. Martinez-Ponce. (6)

(1) State Commission for Protection against Sanitarian Risks, Ministry of health at michoacan state, Morelia, Mexico; (2) National University Autonomous of Mexico, Campus morelia, Morelia, Michoacan, Mexico; (3) State Laboratory of Public Health, Ministry of Health at Michoacan State, Morelia, Mexico; (4) Technical Secretary, Ministry of Health at michoacan state, Morelia, Mexico; (5) Ministry of Health, Ministry of health at michoacan state, Morelia, Mexico; (6) Ministry of Health, Ministry of Health at michoacan state, Morelia, Mexico.

Objective: To show the epidemiological reports of the impact of air pollution and climate change in Michoacan State, Mexico since 2009 to 2013. Data sources: our main reports were measured with parameters like temperature and precipitations during 1950–2000; and climate change scenarios projected to 2020, 2030 and 2050. Also, ozone like air pollutant, 2010–2012 A/H1N1 spring outbreak; floods and acute respiratory and diarrhoelic infectious diseases, dermatitis and conjunctival diseases related with contaminated food, air, water and soil after intense rainfalls; surveillance health system of michoacan.

Methods: Samples were obtained and sent to state public health laboratory in Morelia, Michoacan. Meteorological reports were obtained and reviewed by the Delegational state of the National Commission of Water and analysed by the Atmospheric Science Center from the National University Autonomous of Mexico in Mexico City. Descriptive epidemiological reports were assessed to complete these reports from the epidemiological surveillance health system of michoacan.

Results: Acute infectious diseases were identified like A/H1N1 flu virus and ozone air pollutant in april and may in 2009. Respiratory and diarrhoelic infectious outbreaks in may 2010 and february 2010 in the Monarch butterfly biosphere region in East Michoacan. In the same year, in april an outbreak of viroli parahaemolyticus were presented. And, recently in 2013 a serial reports related with a low level pH decrease in the Pacific ocean coast and the presence of enterococcus were measured. All these results were associated with temperature, precipitations and climate change scenarios since 1950–2000 and 2020, 2030 and 2050 measures in Michoacan.
Simulations of Pollutant Dispersal over Nairobi City, Kenya

G. Otieno (1)
(1) University of Nairobi, meteorology, Nairobi, Kenya

The current rapid deterioration of air quality in urban centres can be attributed to urbanization. Poor air quality has been associated with several negative effects on human health, climate and ecosystems. Most cities in developing countries, especially in Africa have poor or in some cases no air quality management systems in place despite having the fastest growing urban populations. City populations have high vulnerability to the impacts air pollution following high density of residents and economic activities as well.

Air pollution is evident in most cities; the case of Nairobi is an illustrative of this. The common air pollutants include carbon monoxide and total suspended particulates among others, the latter being the most widespread and the most serious for human health.

This study simulated air pollutant dispersal over the city using Hybrid single particle Lagrangian integrated trajectory (HYSLIT), considering a case for emission of total suspended particles into the environment. The predominant wind speed over the city is 4–6 knots and the wind direction is westerly. The backward trajectory of a pollutant released in the city is generally observed to flow to the western side of the city. The pollutant is observed to be dispersed beyond 100 km from the city reducing the concentration of the same in the city.

The study thus recommends for a consultative planning process of the city that factors in the wind characteristics over the city. Most industrial activities should be relocated to the extreme western side of the city to minimize concentration of pollutants over the city. The study further recommends studies that studies be carried out to ascertain the quality of rain water during the long rain season.

Impact of hot weather on injuries and accidents in high income countries - a literature review

E. Otte Im Kampe (1); S. Hajat (1); S. Kovats (1)
(1) London School of Hygiene and Tropical Medicine, London, United Kingdom

Introduction: Given predictions of increased frequency of hot weather periods due to climate change it is crucial to have prevention measures in place to reduce the health burden of heat waves. Since injuries have often been overlooked in relation to hot weather the aim of this review is to summarize the evidence on the effect of hot weather on unintentional injuries in high income countries to inform public and programme initiatives designed to reduce the burden of injuries. Methods: The following data bases were searched (28/02/2015): Global Public Health, Embase, Medline. Studies reporting heatstroke were excluded as the purpose of this review is to report on non-heat related injuries. Eligibility was assessed by one reviewer. 19 studies were included. Results: Preliminary results of this review showed for 15 out of 19 studies an increased risk of unintentional injuries due to hot weather. A Spanish study reported that 60% (69) of all firefighter deaths due to a wildfire fire entrapment occurred on high summer days. In the Netherlands an increase of 15% on the 135% of emergency room patients for each 1°C increase was observed above a threshold of 6°C. In France an excess mortality due to injury and poisoning in particular for people under 35 years was reported. Hot weather conditions in Italy showed higher risk for work-related accidents, in particular on early summer days. 3 studies from the US showed for high temperatures a strong increase in hospital admissions in accidental causes and an increased risk of fatality due to accidental cocaine overdose. In contrast, 1 study from Australia did not find an association between emergency hospital admissions due to injuries during extreme heat. Another Australian study found that decreases in sport accidents, falls and blunts in children and a decrease in motor vehicle related accidents among the elderly. Conclusions. To our knowledge, this is the 1st review of the effect of hot weather on unintentional injuries. Our review indicates that hot weather periods may increase the risk of unintentional injuries and accidents in high income countries. The results are valuable for health system planning and injury prevention strategies.

Air Pollution Transport Processes and Human Health Impacts over the Middle Hill Urban Centers of Nepal Himalaya

RP. Regmi (1)
(1) Tribhuvan University, Central Department of Physics, Kirtipur, Kathmandu, Nepal

Urban centers of Nepal are mostly located in deep valleys, narrow river basins and in southern plain areas, more or less shaped like valleys and in proximity to the high mountains. The meteorological conditions associated with such topographic features have been found to be highly adverse and may build up severe air pollution even where the local emissions are low. In consideration with their topography and meteorological conditions that could potentially prevail, Nepalese urban centers in the middle hills are expected to be highly vulnerable to air pollution. Prevalence of dust, particulate and other pollutants in the ambient air of these urban centers have already reached to an unacceptable level. The lack of necessary knowledge on air pollution emission pattern, the carrying capacity, mechanism of transport and formation of pollutant fields in these swelled urban centers have given rise to serious air quality deterioration and the associated quality degradation, development of control systems, and urban planning. Observations and numerical simulation studies on prevailing wintertime meteorology and air pollutants distribution and their dynamics have revealed that the bowl-shaped Kathmandu valley possesses high air pollution potential due to its adverse topographical and topographic conditions particularly during the dry winter season. The poor dispersion power of the valley can easily reach into its saturation if substantial amount of air pollution is continuously loaded into its atmosphere. Concurrent observation of health–air pollution exposure status based on the results of numerical models revealed that more than 52% of total Kathmandu residents were living in areas with concentration above 40 µg/m³ of PM10. Significant health endpoints attributable to PM10 over the Kathmandu valley have been predicted. Other urban centers are developing in the same pursuits. In this paper, we will present the atmospheric transport processes over the middle hills of Nepal Himalaya and their role in pumping up the lowland pollutants up into the Himalayas including the prevailing wintertime meteorology, mechanism of air pollution transport and formation of pollutant fields, human exposure and health endpoints over the Kathmandu valley.

Seasonal variations of aerosols in Pakistan: Contributions of domestic anthropogenic emissions and transboundary transport

M.Z. Shahid (1)
(1) Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing China, State Key Laboratory of Atmospheric Boundary Layer Physics and Atmospheric Chemistry, Beijing, China

Air pollution has become a serious challenge for developing countries like Pakistan. Very scarce information is available regarding pollution levels in this geographically diverse region. This study presents the first modelling work to simulate the spatial distribution and temporal variation of aerosol concentrations over Pakistan for using the Weather Research and Forecasting Model coupled with Chemistry (WRF-Chem). Simulated aerosol species include sulfate, nitrate, ammonium, organic carbon, black carbon, and...
PM$_2.5$ (particles with a diameter of 2.5 mm or less), which are confirmed by high dust storms and rapid growth of industries, have been measured using satellite measurements. In year 2006, simulated PM$_2.5$ concentrations averaged over northeastern Pakistan (71–74.5°E, 28–34°N) are 55, 48.5, 31.5, and 98 µg m$^{-3}$ in January, April, July, and October, respectively. The simulated highest PM$_2.5$ concentration in October results from the relatively low temperatures that favor nitrate formation as well as the lowest precipitation that leads to the smallest wet deposition of all aerosol species. The simulated lowest concentration of PM$_2.5$ in July can be attributed to the largest precipitation associated with the South Asian summer monsoon. Sensitivity studies show that the transboundary transport contributes to PM$_2.5$ aerosol levels in northeastern Pakistan by 10–20% in January and April and by 10–40% in July and October of year 2006. Wind over India and Pakistan is found to be the major determining parameter that determines the transboundary aerosol transport.

P-1121-14
Enhanced critical load capacity of soil due to buffering of atmospheric acidity through deposition of soil derived particulate matter in Delhi (India)
D. Sharma (1)
(1) Jawaharlal Nehru University, School of Environmental Sciences, New Delhi, Delhi, India

This paper reports air quality characterization using data of MODIS-derived aerosol optical depth (AOD) and measured Suspended Particulate Matter (SPM), NO$_2$ and SO$_2$ values across India. The levels of these pollutants were mapped using geospatial techniques. The results show significant differences in the levels of SPM, NO$_2$ and SO$_2$ across rural and urban sites. In general, districts of central and northern India show relatively higher SPM concentrations as compared to southern India. The SPM values were noted to have a significant correlation with the AOD values at different sites. Further a trend analysis of SPM, NO$_2$ and NO$_2$ in the Delhi region, which was carried out using the Central Pollution Control Board (CPCB) data, revealed a continuous increase in the SPM levels in the city. This lead to the calculation of the critical load of atmospheric acidity for nitrogen and sulphur in order to check the vulnerability of the soil systems in Delhi. A Critical Load approach similar to the one used in European method, was applied to assess the vulnerability of natural systems to the current day atmospheric-based scenarios in the capital city of Delhi. The calculated values of critical loads of sulphur (225 – 375 eq/ha/yr) and nitrogen (298 – 303 eq/ha/yr), for the soil system in Delhi, were calculated with respect to different grass, herbaceous and black siris. According to the results, present loads of sulphur (PL(S) = 26.40 eq/ ha/yr) and nitrogen (PL(N) = 36.51 eq/ha/yr) were found to be much lower than their critical loads which means that the smallest loading of all aerosol species, and the capital city of Delhi. The study indicated that the system is still protective due to high pH of the soil. The nature of buffering capability of calcium derived from soil dust can be considered as a natural tool to combat acidification in the Indian region. The results showed that the pollution status in Delhi is still within the safe limits. However, at the pace at which the city is growing, it is likely that in coming decades, it may exceed these critical values. The approach is very useful, not only in abating pollution but also in devising means of cost optimal emission abatement strategies, and can be applied across the entire Indian region.

P-1121-15
Characteristics of aerosol optical and physical properties during major dust storm and intense biomass burning events over a mega-city of Lahore (Pakistan)
S. Tariq (1)
(1) University of the Punjab, Remote sensing and GIS group, department of space science, Punjab, Pakistan

Aerosol particles released due to natural and anthropogenic activities have very important effects on human health and climate of the region. In the present study aerosol optical and physical properties have been analyzed during major dust storm (March 2012) and intense biomass burning (October 2013) events over a mega-city of Lahore (Pakistan). In this work we have used AERONET data (level 2.0) to analyze the aerosol optical depth (AOD), Angstrom exponent (440/870) (AE), fine mode fraction (FMF), volume size distribution, single scattering albedo (SSA), real and imaginary parts of refractive index (RI), asymmetry parameter (ASY) and aerosol radiative forcing. We have also used available satellite based measurements during both events. ARL’s HYSDPS (Hybrid Single Particle Lagrangian Integrated Trajectory) model backward trajectories were also computed to understand the transport of aerosol particles during both the events. The daily average AOD value (2.17) at 500 nm was found to be highest on 20 March 2012 with corresponding FMF value of 0.27 indicating the dominance of coarse mode particles due to dust storm over Lahore. While during intense biomass burning event peak value (2.36) of AOD was observed on 9 October 2013 with corresponding FMF value of 0.97 pointing towards the fact that fine mode aerosol particles have greater contribution towards total AOD in the atmosphere of Lahore. Volume distribution was observed to be maximum (~1.7) at a radius of ~1.69 on 20 March 2012, whereas volume concentration (~0.33) was found to be highest at a radius of ~0.27 during 9 October 2013. Significant increase in SSA with wavelength was observed during dust storm while during biomass burning period it decreased with wavelength. Aerosol radiative forcing was found to be ~265 and ~199 Wm$^{-2}$ during dust storm and biomass burning periods respectively.

P-1121-16
Numerical Characterization of the NOx Formation during MSW Incineration
AB. Timoleon (1)
(1) Faculté des Sciences, Université des Sciences et Techniques de Masuku, Chimie, Franceville, Gabon

A numerical model has been developed (Chemkin) to study combustion processes in a fixed bed reactor. The test section is divided into several successive Perfect Stirred Reactor (PSR). At the entry, the thermal degradation species of the solid are used as input and at the exit the exhaust gases are recovered. Comparison of previously experimental results and the current model output has been compared with good agreement. The study demonstrates that the NO formation and reduction is controlled by the combustion regime so are mainly dependant of the primary excess air of combustion. The model has been used to establish the reaction pathways of formation and reduction of the NOx at different locations in the reactor as a function of this parameter. This has allowed defining what is occurring at each specific location of the reactor. The reaction pathways and sensitivity study has shown that the production of NO is controlled mostly by local oxygen concentration, thus the location of the NO production region depends mostly on the primary air injection. From this description of the principal reacting zones and of the intermediate species it is possible to develop and to optimize primary technique of NOx reduction.
Global warming and sea level rise

A. Cazenave (1)
(1) CNES, LEGOS, Toulouse, France

It is now well established that the Earth’s climate is warming because accumulation inside the atmosphere of greenhouse gases produced by anthropogenic fossil fuel combustion and land-use change (mostly deforestation). Global warming has already several visible consequences, in particular increase of the ocean heat content, melting of glaciers, and ice mass loss from the Greenland and Antarctic ice sheets. Ocean warming and land ice melt in turn cause sea level rise. Sea level rise induced by global warming and its impacts in coastal zones has become a matter of great interest for the scientific community, and the media and public. In this presentation, we summarize the most up-to-date knowledge about climate change and associated impacts on ocean warming, land ice melt and sea level rise. We also present seal-level projections for the 21st century under different warming scenarios, highlighting the regional variability that superimposes the global mean rise. Finally, we briefly discuss the coastal zones case where climate-related sea level rise generally amplifies the vulnerability of those regions already impacted by many other factors due to natural phenomena and direct anthropogenic forcing.

Greenland ice cores tell tales on the extent of the Greenland Ice Sheet during past warm climate periods

D. Dahl-Jensen (1)
(1) Centre for Ice and Climate, Niels Bohr Institute, University of Copenhagen, Copenhagen, Denmark

Knowledge on the long-term response of the Greenland ice sheet to climate warming during past interglacial periods is essential for estimating the potential future rise in sea level. During the last million years, the Greenland Ice Sheet (GRIS) has waxed and waned in response to glacial and interglacial periods. The deep ice cores through the Greenland ice sheet provide evidence of the climate of the time. Ice from the last interglacial period (the Eemian, LIG)130 to 115 kyrs before present is present in most of the deep ice cores and can be used to determine both temperature and precipitation of the ice sheet during this warm interglacial period. Going to the bed, basal material enclosed in the ice cores contain DNA remnants that can be used to determine the ecosystems present before ice covered the land. The reaction of the Greenland ice sheet to climate changes and the sea level change from mass loss from the Greenland ice sheet is discussed based on the ice core findings.

Uncertainties in Mass Balance Studies of the Arctic Sea Ice Cover

J. Comiso (1)
(1) NASA Goddard Space Flight Center, Cryospheric Sciences Laboratory, Code 615, Greenbelt, MD, United States of America

The longest continuous observations of the global sea ice cover are those derived from satellite passive microwave sea ice data starting with the launch of the Nimbus-7 SMMR in October 1978 and followed by a series of DMSP/SSM/I sensors launched from July 1987 to the present. These capabilities were further improved with the launch of Aqua/AMSR-E which provided higher resolution data from June 2002 to October 2011 and followed by the launch of GCOM-W1/AMSR2 which has been in operation from 2012 up to the present. Putting together an accurate time series data set has been a challenge because of differences in fields-of-view, antenna side-lobes, calibration and other physical attributes of the different sensors. Through comparative analysis of overlapping data, however, some of these problems have been minimized and the accuracy in the assessments of the variability and trends of ice extent and ice area has been optimized. The ice extent provides the sum of areas in the ocean that has ice cover of at least 15% ice concentration while ice area includes the actual area covered by ice and used to estimate the ice volume assuming that the average thickness of the ice cover is known. The current record from 1978 to 2015 shows a trend in ice area consistent with a 0.16% per decade for the yearly average but a more drastic change is observed for the thick multiyear ice the trend of which is about 1.49±1.6% per decade suggesting large declines in the average ice thickness of this ice type. Measurement of ice thickness have been the source of greatest uncertainties since accurate, continuous and consistent time series measurements of global ice thickness are not available. Historically, ice thickness measurements have been sparse and were done primarily using upward looking submarine sonar data which have been used to show a significant increase in average winter ice thickness from about 0.3 m in 1980 to 2.9 m in 2006. Ice freeboard measurements from ICESat/GLAS (January 2003–February 2010) provide more extensive coverage and indicate a change in ice thickness from about 2.4 m in 2004 to 1.9 m in 2008. More recent freeboard measurements from CryoSat2 (April 2010 to the present) provided a continuation of the satellite measurements and show a more stable thickness. Inter-comparison of thicknesses from freeboard measurements have indicated relatively low biases (less than 0.1 m) compared to in situ and other measurements, there are large standard deviations (0.7 m) in the results. Although more accurate snow thickness and ice density data are needed. The use of the improved measurements of average sea ice thickness separately for seasonal and multiyear ice in conjunction with passive microwave data would provide the desired estimate for average volume of the two major ice types. Time series of such data are needed in mass balance studies of the Arctic sea ice cover and uncertainties associated with the use of current data sets will be provided.

What can we learn from the recent global warming hiatus about climate variability and climate models?

H. Douville (1) ; A. Voldoire (1)
(1) Météo-France, CNRM-GAME, Toulouse, France

The observed rise in global mean surface air temperature (GMST) has slowed down over the last 15 years, spurring outbreaks of skepticism regarding the nature of global warming and challenging the upper range transient response of the current generation global climate models. Recent numerical studies have, however, tempered the relevance of the observed pause in global warming by highlighting the key role of tropical Pacific internal variability. Here we first show that many climate models overestimate the influence of the El Niño Southern Oscillation on GMST, thereby shedding doubt on their ability to capture the tropical Pacific contribution to the hiatus. More recently, model results suggest that tropical Pacific internal variability is more suited to the experimental design. We argue that overriding the surface wind stress is more suitable than nudging the sea surface temperature for controlling the tropical Pacific ocean heat uptake and, thereby, the multidecadal variability of GMST. Using the former technique, our model captures several aspects of the recent climate evolution, including the weaker slowdown of global warming over land and the transition toward a negative phase of the Pacific Decadal Oscillation. Yet the observed global warming is still overestimated not only over the recent 1998–2012 hiatus period but also over former decades, therefore we suggest that key processes are still not well prescribed to the prescribed radiative forcings. Besides fully coupled ocean–atmosphere simulations, we therefore advocate the use of suitable partial–coupling techniques to control a fraction of the internal climate variability. This strategy could enable a more insightful comparison with the
observed climate variability and, thereby, lead to stronger observational constraints on the model sensitivity to the prescribed radiative forcings.

**O-1122-02**

Eurasia winter cooling in a recent warming hiatus period of 1998-2012

C. Li, (1) ; J. Marotzke, (1)
(1) Max Planck Institute for Meteorology, The Ocean in the Earth System, Hamburg, Germany

The global–mean surface temperature (GMT) has shown a comparatively small warming trend over 1998–2012, termed a hiatus [Meehl et al., 2011; Flato et al., 2013; Kosaka and Xie, 2013]. In addition to the warming hiatus of GMT in the recent decade, Cohen et al. [2012] found a significant winter (seasons refer to those for the Northern Hemispheric hereafter) cooling trend on the Northern–Hemispheric mid-latitude winter cooling is poorly understood. Here we investigate the spatial pattern of surface temperature trends and the contribution of temperature trend at different latitude bands and also the mechanism of the NH mid–latitude winter cooling are poorly understood. Here we investigate the spatial pattern of surface temperature trends and the contribution of surface temperature trend reduction at different latitude bands with observational data, and the causation of NH mid–latitude winter cooling with large ensembles of AMIP-type sensitivity simulations.

In addition to the tropical Pacific cooling over 1998–2012, we find the GMT warming hiatus is strongly influenced by a pronounced DJF cooling trend over 1998–2011 in NH mid–latitude, especially in Eurasia. However, an absent of the strong mid–latitude winter cooling trend in the previous studies with restoring the observed SST over tropical Pacific in a coupled climate model Kosaka and Xie [2013] underlines that mechanisms other than cooling in the tropical Pacific must contribute to the warming hiatus in recent decade. In the present study, we explore the impact of the dramatic loss of Arctic sea ice on the NH large-scale circulation changes and the NH mid–latitude winter cooling trend. We found that the Arctic sea ice does not drive systematic changes on the NH large-scale circulation as Arctic Oscillation (AO), Pacific/North American Pattern (PNA) and the Eurasia winter blocking frequency in the past decades. And the observed DJF cooling trend over 1998–2012 is a random internal variability and belongs to a extreme climate events. Although the dramatic loss of Arctic sea ice does not drive systematic cooling trend of Eurasia winter, but it can enhance the variability of Eurasia winter, and thus the possibility of the Eurasia winter reaching an extreme cold trend over 1998–2012.

**O-1122-03**

Impacts of External Forcing on the Decadal Climate Variability in CMIP5 Simulations

Y. Yu, (1) ; Y. Song, (1)
(1) Institute of atmospheric physics, Chinese Academy of Sciences, Beijing, China

Decadal climate variability is usually regarded as an internal variable in the climate system. However, using the coupled simulations from the Coupled Model Intercomparison Project Phase 5 (CMIP5), we have demonstrated that the external radiative forcing plays an important role in modulating decadal variability of the global mean surface air temperature (SAT). In historical runs, the standard deviations of the global mean SAT exhibit robust increases relative to pre-industrial runs, indicating that radiative forcing acts on decadal variability of the global mean SAT through enhancing amplitude and modulating phase. By comparing model results using different external forcing agents, we find the natural-forcing agent has the strongest impact on the decadal timescale. Every type of simulation (e.g., the pre-industrial, historical, natural forcing and anthropogenic forcing runs) from almost all the CMIP5 models exhibits a higher forcing between the natural-forcing runs and thus increases of the modelled SAT are much higher than those from pre-industrial runs. This is because that the decadal SAT anomalies from multiple models cancel each other out in the pre-industrial runs without external forcing, but generally follow decadal evolution of the external forcing with a 13 month lag. The most significant responses to external forcing are found in the tropical Indian and Pacific oceans, through with different physical mechanisms for the natural and greenhouse gas forcing agents.

**O-1122-04**

Change Points of Global Temperature

N. Cahill (1) ; S. Rahmstorf (2)
(1) University College Dublin, Mathematical Science, Dublin, Ireland; (2) Potsdam Institute for Climate Impact Research, Potsdam, Germany

We aim to address the question of whether or not there is a recent ‘hiatus’, ‘pause’ or ‘slowdown’ of global temperature rise. Using the statistical technique known as change point analysis we identify the statistically significant changes in four global temperature records and estimate the rates of temperature rise before and after these changes occur. In each case the results indicate that three change points are enough to accurately capture the variability in the data with no evidence of any significant change in the global warming trend since ~1970. We conclude that a hiatus or pause cannot be statistically justified.

**O-1122-05**

Impact of initial conditions and atmospheric model resolution in predicting “Climate Hiatuses”

S. Corti (1)
(1) National Research Council (CNR), Institute of Atmospheric Science and Climate (ISAC), Bologna, Bologna, Italy

The results from a set of multi–year hindcasts carried out with the ECMWF coupled system at two different resolutions of the atmospheric component will be presented. The first experiment consists of a control series of ensemble hindcasts with the atmospheric model integrated at T255 with 91 levels in vertical (this is the current resolution of the ECMWF System4). The ocean resolution is the standard NEMO–ORCA1. In the sensitivity experiment the atmospheric resolution has increased to T511 (the ocean resolution is the same). By comparing the control and the sensitivity experiment we estimate the impact of the increased atmospheric resolution on forecast quality.

The impact of initial conditions relative to external forcings in multi–year integrations is further assessed using specifically designed sensitivity experiments. They consist, for each atmospheric resolution, of three sets of ensemble hindcasts for three initial dates in 1988, 1994 and 2002 using either the external forcings from the ‘correct’ decade or swapping the forcings between the three decades. By comparing the three sets of integrations, the impact of external forcing versus initial conditions on the predictability over multi–annual time scales is estimated. In particular we estimate the sensitivity of the model to initial conditions and horizontal resolution in predicting the multi–year climate oscillations that modulate the global warming trend, also known as ‘Climate Hiatuses’.

**O-1122-06**

Multi-model simulations of radiative forcing of aerosols and ozone during the 1990-2015 period

G. Myhre (1) ; BH. Samset (2) ; Ø. Hodnebroeg (1) ; RB. Skeie (1) ; Z. Klimont (3) ; G. Faluvegi (4) ; D. Shindell (5) ; M. Flanner (6) ; D. Olivie (7) ; S. Tsyo (7) ; M. Schulz (7) ; R. Cherian (8) ; J. Quaas (8) ; J. Mülmenstädt (8) ; T. Takemura (9) ; J. Schnell (10) ; M. Prather (10)
(1) CICERO, Oslo, Norway; (2) CICERO, Climate System, Oslo, Norway; (3) IAASA, Laxenburg, Austria; (4) GISS, New York, United States of America; (5) Duke University, Durham, United States of America; (6) University of Michigan, Ann Arbor, United States of America; (7) Met.no, Oslo, Norway; (8) University of Leipzig, Leipzig, Germany; (9) Kyushu University, Kyushu, Japan; (10) University of California, Irvine, Irvine, United States of America
0123 - Climate change education for sustainable development

P-1123-01
Climate Change Engineering: An emerging pathway to address Climate Change Challenges
A. Batisha (1)
(1) Environment and Climate Change Research Institute, Cairo, Egypt

To survive in the future, the professional engineers should be qualified to deal with different and diverse subjects of climate change challenges. The focus of this work is to bridge the gap between the academia and the professional practice in the field of Climate Change CC. So, the professional engineers should have an adequate knowledge about wide and different Climate change engineering CCE disciplines. The focus of CCE is to promote sustainability and optimally responding to CC challenges. CCE may be defined as the application of mathematical, scientific, environmental, and technical knowledge to invent, design, build, maintain, and improve structures, products, machines, devices, systems, materials and processes for the purpose of sustaining both the global and local properties of the Earth and its habitability. The paper focuses on the purpose, activities; and issues of CCE. The role of Climate change engineer has been addressed. This paper aims to highlight CC with invaluable insights into multidisciplinary engineering that help improve current operations and shape future strategies in the Era of Climate Change. The relevant conclusion is that the CCE plays a crucial role in the success process or failure of development efforts must be considered by applying CCE principles.

P-1123-02
Education on climate change through generation of local data
R. Curcoll (1) ; A. ÁGueda, (1) ; O. Batet, (1) ; S. Borràs, (1) ; L. Cañé, (1) ; C. Grossi, (1) ; M. Nofuentes Ramos, (1) ; P. Occhipinti, (1) ; E. Vazquez, (1) ; X. Rodó (2) ; JA. Morgui (1)
(1) Institut Català de Ciències del Clima, Lab atmosphere & oceans, Barcelona, Spain; (2) Institut Català de Ciències del Clima (IC3), Climate dynamics and impacts unit, Barcelona, Spain

Education covers a key part in the global response to climate change. Understanding the behaviour of ecosystems, the role of the cities or the orders of magnitude of atmospheric greenhouse gases concentrations help scholars and citizenship to gain a more conscious and active attitude on the climatic challenge and its causes.

Researchers from the Laboratory of the Atmosphere and Climate (IC3) in the Catalan Institute of Climate Science (IC3) have developed several educational activities of outreach and workshops with scholars and citizenship to make the population aware of the causes generating climate changes and how they can contribute in reducing it. All these activities share a common aim: scholars or citizens generate and collect quality data allowing them to better understand processes that happen in our environment, regarding our anthropogenic processes. Another important objective of these educational activities consists in making scholars and citizenship active participants of the scientific community discussing and studying the generated data with other groups.

The kind of measurements can be, for instance, atmospheric greenhouse gases concentrations, meteorological parameters or radiation measurements. Data generated from these measurements allow knowing the general greenhouse gases concentrations in the atmosphere and the relation between the different gas emissions: this kind of studies makes the citizenship much more aware in understanding the role of cities in the global emissions or the relation of the ecosystems behaviour with water and temperature.

P-1123-03
Mainstreaming climate change into fisheries and aquatic sciences curriculum and training in tertiary academic institutions
J. Efitre (1) ; R. Oquttu-Ohwayo (2) ; W. Okello (3) ; C. Odongkara (4) ; V. Natugonza (2) ; L. Musinguzi (5)
(1) Department of Biological Sciences, Makerere university, Kampala, Uganda; (2) National Fisheries Research Resources Research Institute (NaFIARRRI), Jinja, Uganda; (3) National Fisheries Research Resources Research Institute (NaFIARRRI), Jinja, Uganda; (4) National Fisheries Resources Research Institute (NaFIARRRI), Jinja, Uganda; (5) National Fisheries Resources Research Institute (NaFIARRRI), Fish habitat Management, Jinja, Uganda

Fisheries resources in Uganda contribute to food security, employment, income and livelihoods but are threatened by over-exploitation, pollution, habitat degradation, invasive species and climate variability and change. However, climate variability and change has been little studied yet it is adding to or interacting with other stressors to affect riparian ecosystems, fish habitats, aquaculture productivity, fish yields and livelihoods. There is inadequate knowledge, training and institutional capacity to address climate change in fisheries in Uganda as in most African countries. There is therefore need to build capacity and mainstream climate change into the curriculum of tertiary training and research institutions. International, regional and national policies have recommended incorporating climate change into education and training in fisheries and aquatic sciences. Some training institutions in Uganda have curricula in basic and applied fisheries and freshwater science but none of these add climate variability and change. This curriculum and manual was therefore developed to address this shortfall. Its overall objective is to mainstream climate change in inland freshwater systems and fisheries. The specific objectives are to: 1) develop a training curriculum and manual that will be used to train students in climate change and fisheries in tertiary education and research institutions and 2) mainstream climate change into the undergraduate and graduate fisheries and aquaculture curricula. This is expected to build scientific and technical capacity to: 1) anticipate and evaluate changes in climate and its impacts; 2) communicate information to stakeholders to enable them design, test and implement adaptation strategies and mitigation measures; 3) increase human resource capacity through reviewing and strengthening the national education system; and 4) promote science and technology
as stipulated in Uganda’s National Development Plan (NDP) and Agriculture Sector Development Strategy Investment Plan (DSIP). The manual is organized into six modules namely: Non-climate factors which together with climate change affect natural resources; Introduction to climate change; Climate change and physical, chemical, and ecological properties and productivity of inland aquatic ecosystems and fisheries; Climate change and aquaculture; Socio-economic impacts, adaptations and mitigations; and Policy, legal and institutional frameworks. Each module consists of units to be delivered through lectures, brainstorming sessions, case studies, field visits, group discussions, computer exercises and seminar presentations. The training curriculum and manual was completed in 2014 and is ready for pretesting in tertiary academic institutions in Uganda.

P-1123-04

The Importance of Environmental Education for Sustainability

M. Eid (1)
(1) Suez Canal University, Faculty of Agriculture, Ismailia, Egypt

It is an undoubted fact that human beings are having a significant impact on the nature environment. As the global population is increasing, the demand for human survival is more and more pressure on a finite number of resources. Human environmental impacts can largely be attributing to consumption patterns. However, the ability to meet the needs of the current generation while preserving the ability of future generation to meet their needs, it would be reasonable to search for way to minimize human impact on the environmental and to build a sustainable world for the future.

It is considered that the best way to raise awareness of sustainability and environmental issued and finally, changing behavior to more sustainable practices is through environment education. Therefore, environmental education is not just about learning, it is about understanding issues confronting our planet and changing individual attitudes values and developing a community of environmental aware towards achieving suitability for the future.

This poster will discuss approaches and principles of environmental education and study case.

P-1123-05

Teaching climate change: An interdiscipli

R. Engelhardt (1)
(1) School of Global Health, UCPH, Copenhagen Center for Disaster Research, Copenhagen K, Denmark

Climate change education is inherently interdisciplinary. It requires teachers to possess a broad range of competencies and to apply alternating teaching methods bringing into play the skills and knowledge of the whole classroom. If one defines interdisciplinary learning as the ability to know and coordinate a growing number of perspectives, it becomes a supervisory task to support students in their explorative and coordinative efforts. A research project running from 2013 to 2016 at the University of Copenhagen has investigated the pedagogical and didactical challenges in two interdisciplinary Master’s Programs – one of them called ‘Master of Disaster’ (MDMa) at the Faculty of Health and the other ‘Master of Science (MSc) in Climate Change’ (CCIMA) at the Faculty of Science.

P-1123-06

Getting from here to a sustainable world: Why “handprint” measurement which drives pro-environment behavior be crucial to addressing climate change?

C. Hemani (1)
(1) Self employed, Ahmedabad, India

Exponential increase in human population from 5 million in 4000 BC to over 7 billion humans in 2012 coupled with unsustainable consumption and production patterns is putting an undue pressure on the limited natural resources. It’s not planet and the diminishing natural resources but our own species at risk if we continue with this present model of development. Thus climate change is not an issue in isolation, but rather, a symptom of a broader challenge: humanity’s systematic overuse of the planet’s finite resources. This accelerating gap between human demand and nature’s supply is leading to another crunch of bio-capacity.

In a world facing climate change issues and a bio-capacity crunch, the winning economic strategies will be preserving bio-capacity on the one hand, and reducing demand for it on the other which in turn would serve as the leading strategies for minimizing climate change. Is it this possible? Climate change and high carbon lifestyles as a narrative of future gloom and doom only disempowers people to act. What if we focus on solution rather than problems? What if we focus on accounting positive actions powered by pro-environment behaviour to drive low carbon lifestyles? Sustainable development would require changes in the way we think and act. And education is one of the most effective mediums to bring about changes in values, behaviour and lifestyles required to achieve sustainability.

Scientifically driven and educative accounting tools like carbon foot print, ecological footprint measures our actions either in terms of amount of carbon dioxide released in the atmosphere or in terms of resource of the earth which would be needed to match our lifestyles and suggests our negative impacts on the environment respectively. While Handprint is a symbol of positive measure for what we can do individually or through collective effort to restore the balance between consumption and the planet’s carrying capacity. Studies suggest that positive accounting not only presents hope but also suggests how it affects behaviour changes in values, behaviour and lifestyles required to achieve sustainability.

This research focuses on developing a scientifically driven educational tool for handprint which in turn establishes links between measuring positive actions via handprint scores driving climate smart behaviour and climate change mitigation potential.

P-1123-07

Studies on research initiatives for developing strategic knowledge on climate change impacts in India

A. Kamavisdar (1) ; R. Kumar (2) ; N. Mendiratta (3) ; R. Singh (3) ; K. Samuel (3) ; A. Gupta (1)
(1) Climate Change Programme, Department of Science & Technology, Govt. of India, New Delhi, India; (2) Access to Knowledge Division, Department of scientific and industrial research, New Delhi, India; (3) Climate Change Programme, Department of science & technology, New Delhi, India

This is well-known fact that Indian economy is based on its natural resources, agriculture and forestry, which are climate sensitive sectors. Considering the above India may expect considerable variations in vulnerability due to projected climate change phenomenon. In response to the same Government has prepared a National Action Plan for Climate Change (NAPCC) comprising of eight
P-1123-09

Does the public policy for influencing pro-environmental behaviour in the developed countries take into account people’s common future under climate change?

Ll. Udrea (1)

(1) Keele University, School of Politics, International Relations and Environment, Staffordshire, United Kingdom

Public policy in the richest countries regarding environmental protection is currently based on ‘monetising’ nature in order to protect the environment.

The UK government tries to tackle climate change using a multitude of approaches however; the most effective ones to influence pro-environmental behaviour in the long term are yet to be found.

In this paper, I will discuss the approaches followed by the UK government to influence people adopt a pro-environmental behaviour pursuing them to change their unsustainable lifestyle using financial incentives, nudging and population segmentation. These approaches give people strong reasons to take the ‘right’ actions in the short term. For these reasons, they need to find by themselves the motivation to act pro-environmentally. As a result, I state that the UK government does not set a straightforward connection between people’s current consumption of climate change and the duty to protect the natural world.

In the UK context, individuals are not informed, but incentivised to act pro-environmentally via a series of price signals or nudges that encourage them to change their behaviour. I argue for the need to offer constructive feedback as a response to people’s harmful behaviour and facilitate the necessary contexts to become aware of unsustainable daily actions.

Moreover, I state that environmental ethics are not often mentioned in the debate about influencing human action for climate change mitigation; even though morality is for the majority of us, a behaviour regulator that can motivate us to take the ‘right’ actions. Therefore, there is not a lot of interest to bring to attention the interdependent relationship between human beings and the environment. Thus, many pro-environmental projects are implemented without having the discussion about what people’s duties and responsibilities towards the environment are.

If people do not understand and assume the change they need to make, they will not acquire environmental attitudes to motivate them to act pro-environmentally in the long term. They will continue to act unsustainably whenever they are not guided by different governmental strategies or do not receive any financial incentive to take a pro-environmental action.

As a consequence, I propose a methodological innovation that explores an alternative interpretation to co-benefits of health of climate change mitigation measures in the health sector and in other sectors. Use of a range of training methods creates an interactive and participatory learning environment. These are intended to enable WHO European Member States to respond to and anticipate capacity building needs for climate change and health. Training resources can assist health policy-makers, planners and practitioners in having a mechanism and assessment of action towards the goal of adaptation to climate change in order to meet health goals and targets.

P-1123-08

Climate change and Health- Training Resources for capacity building

V. Kendrovski (1) ; B. Menne (2) ; S. Gerardo (3) ; J. Creswick (4) ; T. Wolf (4)

(1) World Health Organization, Regional Office for Europe, European Centre for Environment and Health, Bonn, Germany; (2) WHO, health security and the environment, Bonn, Germany; (3) WHO, Bonn, Germany; (4) WHO, Cgs, Bonn, Germany

As climate change and its respective health effects are being observed across Europe, it is being suggested that development and implementation of adaptation strategies to protect human health should be accelerated and strengthened. Health adaptation to climate change involves knowledge and skills in a range of professions and across various sectors – not only technical but also social and environmental. A training approach has been missing for many years. The available information is now presented in a structured modular collection in order to make these valuable resources accessible and utilisable. The WHO Regional Office for Europe has developed a collection of training resources for capacity building on climate change and health. The overall aim is to support the development of climate change and health strategies and action plans by providing scientific, technical, methodological and practical background information and training to member states. The training material offers an opportunity to raise awareness among professionals with regard to observed and projected climate change in Europe, and related health effects, and to support health adaptation planning and development of adaptation strategies and action plans.

The training resources (manual + suggested training materials) contain a structured compilation of existing and new training materials according to defined categories of learning objectives. The main objectives of thematic blocks cover the basics of climate change and associated health effects – one presents a framework for the development of adaptation strategies and programmes of action – one co-benefits of health of climate change mitigation measures in the health sector and in other sectors. Use of a range of training methods creates an interactive and participatory learning environment. These are intended to enable WHO European Member States to respond to and anticipate capacity building needs for climate change and health. Training resources can assist health policy-makers, planners and practitioners in having a mechanism and assessment of action towards the goal of adaptation to climate change in order to meet health goals and targets.

P-1123-09

Climate change and Health- Training Resources for capacity building

V. Kendrovski (1) ; B. Menne (2) ; S. Gerardo (3) ; J. Creswick (4) ; T. Wolf (4)

(1) World Health Organization, Regional Office for Europe, European Centre for Environment and Health, Bonn, Germany; (2) WHO, health security and the environment, Bonn, Germany; (3) WHO, Bonn, Germany; (4) WHO, Cgs, Bonn, Germany

As climate change and its respective health effects are being observed across Europe, it is being suggested that development and implementation of adaptation strategies to protect human health should be accelerated and strengthened. Health adaptation to climate change involves knowledge and skills in a range of professions and across various sectors – not only technical but also social and environmental. A training approach has been missing for many years. The available information is now presented in a structured modular collection in order to make these valuable resources accessible and utilisable. The WHO Regional Office for Europe has developed a collection of training resources for capacity building on climate change and health. The overall aim is to support the development of climate change and health strategies and action plans by providing scientific, technical, methodological and practical background information and training to member states. The training material offers an opportunity to raise awareness among professionals with regard to observed and projected climate change in Europe, and related health effects, and to support health adaptation planning and development of adaptation strategies and action plans.

The training resources (manual + suggested training materials) contain a structured compilation of existing and new training materials according to defined categories of learning objectives. The main objectives of thematic blocks cover the basics of climate change and associated health effects – one presents a framework for the development of adaptation strategies and programmes of action – one co-benefits of health of climate change mitigation measures in the health sector and in other sectors. Use of a range of training methods creates an interactive and participatory learning environment. These are intended to enable WHO European Member States to respond to and anticipate capacity building needs for climate change and health. Training resources can assist health policy-makers, planners and practitioners in having a mechanism and assessment of action towards the goal of adaptation to climate change in order to meet health goals and targets.
the individual costs and impacts of personal actions on our shared environmental context and on the other hand, it will provide us with constructive feedback in order to understand the benefits of taking pro-environmental action in the long term.

At present, it seems easier to convince people to act pro-environmentally by working with their short term motivations for action, than helping them adopt sustainable habits in the long-term. As a result, the current UK governmental approaches to influencing pro-environmental behaviour have a negative impact on people’s behaviour and might perhaps weaken their sense of moral responsibility towards nature, in the context of environmental degradation.

In conclusion, I hope that the ‘shared morality’ initiative applied in moral theory can become an ideational trend in environmental governance and policymaking that will offer activists and decision-makers alike grounds for an alternative approach to meeting the challenge of climate change mitigation and encouraging pro-environmental behaviour.

P-1123-10

Ciclania: Videogame for generating sustainable educational communities

B. Mauricio (1); J. Roa, (1); M. Mellado (1)
(1) Universidad Santo Tomás, Santiago, Chile

The challenges facing mankind today associated with the phenomenon global change put us in a scenario of crossroads, which will determine the conditions of our future together.

The increase in atmospheric temperature; biodiversity loss; changes in land use; problems of freshwater availability, ocean acidification; inequality and poverty are some of the effects of the phenomenon, widely studied by the scientific community and those who have sounded the alarm. (IPPC, 2013; Peters, 2011).

But this warning is not enough to change the countries and citizens behavior. During the last forty years we’ve learned that global change will not be solved solely by technological developments, but together with the creation of new citizens with transformed community living arrangements.

Thus, civic education on these matters becomes relevant in the transformation of sensitized responsible citizens. To achieve this transformation, the approach proposed by this work consists in civic education driven by the scientific education.

With this premise we develop Ciclania, a free game build up on the framework of the science program for primary schools of the Ministry of Education of Chile. Ciclania includes 5 environments: beach, field, forest, industrial city, and Egopolis, the city of consumption. The player must explore the environment solving problems associated with global change. In addition to the game, we developed an interactive guide for teachers, which brouzes the game environments (without the need of playing the game) and experimental activities for the classroom, that will give teachers the knowledge and space to deepen the key concepts of global change.

The evaluation results, show that the use of Ciclania promotes learning and motivation in science through play and fun, but mainly promotes in children reasons why we need as a community a more harmonious relationship with the environment in order to battle the global change.

P-1123-11

Engaging Children for a Sustainable Earth: The Case with Global Climate Ambassadors

U. Muhammad (1)
(1) Centre for Renewable Energy and Action on Climate Change, Gusau, Zamfara, Nigeria, Federal Republic of Nigeria

Introduction

The paper tends to look at the role of engaging children to make a difference in their communities especially taking actions that are climate friendly at local level and paper further examines how Global Climate Ambassadors GCA program brought together 17 organizations and 131 children from 7 countries to participate in the program in developing best practices on involving children and youth for a sustainable future thus; the paper also looks at how their participation in the 40th Plenary Session of the IPCC change the entire landscape of climate change negotiations and awareness campaign among children.

Objectives

Is to empirically research on whether there is any impact of engaging children as change agents and also if the yardstick measure of the outcome of their engagement is applied, look at the significance of children’s engagement in climate change negotiations and the impact it has for global sustainability. To understand if cross boundary programs of children can have a positive impact on sustainable development.

Methods

The research uses both primary and secondary data; relevant research works from scholars was looked at and gives more emphasis on the report of the program. Thus; 7 children were interviewed to know the extent of their understanding in the program and how positively it has impacted their lives, if the connection and networking at their level has anything to improve their capacity at the intercontinental connections. The work adopts analytical and descriptive method as well.

Results

The analysis of the work has shown significant understanding of sustainable development and how climate change affects everyone on earth, among the 7 children interviewed 6 strongly agreed that the program had impacted positively in their understanding of what climate change is all about, and they all strongly agree connecting them with their peers out their countries will increase their chances of sharing ideas and learning from each other.

P-1123-12

An Open-Source Climate Change Curriculum for University Education Based on IPCC Synthesis Science

K. Nicholas (1); P. Ambros (2); N. Nasir (2); E. Redford, (2); C. Tsoi (2); MS. Weschke (2)
(1) Lund University, Centre for Sustainability Studies, Lund, Sweden; (2) Lund University, International master’s programme in environmental studies and sustainability science, Lund, Sweden

In order to meaningfully participate in a civic society increasingly shaped by climate change, a climate-literate citizen should be able to read and understand the summaries for policymakers produced by the IPCC, which represent the current state of the art in the scientific understanding of climate change. However, although outreach and dissemination efforts have been increasing, to date we are not aware of any efforts to link the IPCC reports with curriculum design in higher education.

Developing such links is essential to ensure that students are equipped with the skills and knowledge they will need. It can also improve teaching experiences through increased efficiency in course preparation, linking teaching and research, and in sharing best teaching practices with participating colleagues.

Here we develop a framework for teaching a comprehensive university course on climate change that is aligned with IPCC synthesis findings, assess how many of its core elements are addressed by courses offered at top international universities, and recommend teaching resources to fully equip students to understand climate change.

To develop the framework, we identified six core topics derived from scientific literature and syntheses, as well as research on effective climate communication. The six core topics were given the short labels: (1) It’s climate, (2) It’s warming, (3) It’s us, (4) We’re sure, (5) It’s bad, and (6) We can fix it. The six core topics were then broken down into two to four major components (e.g., “Observed changes”...
Socio-Scientific Teaching and Learning: Climate Change Concepts and Issues

M. Pagunsan (1); J. Omay (2); S. Delgado-Confesor (3)

(1) UNESCO Jakarta Office, Education Unit, Jakarta, Indonesia; (2) Sibalom National High School, Sibalom, Antique, Philippines; (3) University of Antique, Sibalom, Antique, Philippines

One of the challenges the teacher faces in introducing contemporary scientific developments into science lessons are the lack of available teaching and learning materials. Materials that are engaging enough that inspires, encourages and develops meaningful learning among students. This paper will present the collaborative project on the development of a Teachers’ Guide Book in Integrating Climate Change Issues in Southeast Asian Schools. Specifically it will present the experiences, best practices and lessons learned in developing a science lesson exemplar through the partnership of teacher trainers and secondary school teachers in Malaysia. The developed science lesson exemplar has undergone students’ try-out in Malaysian secondary school. Then, the implementation of the said science lesson exemplar in Philippines’ secondary school will be highlighted. This paper will also provide lessons learned in developing science lesson exemplar that integrates climate change concepts and issues. It will also present its usability, applicability and replicability implications as the Adaptive Environment of Nations (A.En) in a capacity-building tool for employees at companies that have adopted social responsibility policies, and for public officials at municipalities that have adopted and are implementing climate-change adaptation/mitigation policies. It is the authors’ conviction that when the general public can experience climate change as a tangible threat, there will be more awareness and actions on the political and economic problems created when the earth’s average surface temperature increases by +2°C or +4°C over the current 15°C. Therefore, the goal of Climate Adventure© is to give a chance to the players in the game to experience the story of the earth by answering the question: how can we make tangible the weather conditions life on Earth as we know it today. The two teams each begin the Adventure with an equal amount of CO₂ molecules; as they interact, they should finish the game with the same amount they had at the beginning, accepting a difference of +1 or -1. Throughout the game, the teams move from one space to the next by answering questions as they walk from the entrance to the exit gate of the atmosphere. During the game, the teams are able to use sources and sinks of carbon to keep their players in balance but they cannot exchange carbon with each other. The team that crosses the exit gate with their CO₂ in balance wins the game. The plan for the future is to promote Climate Adventure© as a capacity-building tool for employees at companies that have adopted social responsibility policies, and for public officials at municipalities that have adopted and are implementing climate-change adaptation/mitigation policies.
of culture for global sustainable development. Europe’s Intangible Cultural Heritage (ICH) – the skills, music, dance, drama, gastronomy, festivals, crafts, etc which have been passed from one generation to the next – is a hugely important resource that has an impact on sustainable development in two ways. ICH is a ‘product’ for the cultural and creative industrial sectors (arts markets, design and crafts), and also as a ‘process’ for the economy and society as an inspiration for creativity and innovation (for instance, in education, science, tourism and social cohesion). Education plays a key role in safeguarding ICH as it enables its transmission, awareness raising and capacity building to a widest community. The connection between ICH and sustainable development is acknowledged by international organisations, academics and political bodies alike. In order to implement the concept of sustainable development effectively, it has to be coined as a part of educational methods. Competences for Lifelong Learning (KCLL) in the European Reference Framework can serve as a common foundation for the development of ICH and education and ultimately to sustain the development. The KCLL includes an overview of all forms of behaviour that equip individuals to participate in an effective and constructive way in social and working life, and particularly in increasingly diverse societies, and to respond to new challenges. This paper discusses how KCLL contributes to activate a sustainable regional development. This paper is part of the ‘ICH-Bildung’ European research project on intangible cultural heritage and education by the European Commission – Szó,PRICE Sklodowska-Curie Actions – Research Fellowship Programme.

Integration of climate change education into school: A case study in Da Nang City, Viet Nam

T. Thi My Thi (1) · P. Chau (2)
(1) HA Noi University of Natural Resource and Environment, Department of Climate Change and Sustainable Development, HA Noi, Vietnam; (2) Department of Education and Training, Da Nang, Vietnam

Extensive damages caused by climate change are being reported daily all over the world, especially in developing countries like Viet Nam, where many people live in poverty, lack of infrastructure, lack of education, and limited access to technologies. The level of damages is highly dependent on the capacities of countries and individuals to adapt to climate change. Thus raising people awareness on climate risks, providing them with knowledge on local adaptation, and building their capacity to be resilient are the ultimate goals of climate change education. In order to find out appropriate approaches to promote climate change education in the specific context of Vietnamese education system, this research concentrates on two important aspects: the capacity of educational governance and educational activities in a way that help to facilitate and sustain climate change education in Viet Nam.

In the scope of this study, a case from Da Nang City will be presented. Da Nang is a coastal city of Viet Nam, which located in the central region. The city is considered as the largest economic center of Central Vietnam and the third largest in the country. It is in top five provinces have the highest literacy rate and net enrolment rates at primary level. However, being a coastal city with three quarters of land covered with mountains, Da Nang is prone to frequent typhoons and heavy rainfall causing widespread flooding. In the last 10 years (2000 to 2010) there have been 21 typhoons directly hitting Da Nang with an average about once every 6.5 years. In 2010, Typhoon Ketsana (Figure 4.17) directly hit south of Da Nang and left eight people dead; ninety-six injured, and damages costing 495 billion VND (about 25 million USD). In October 2012, Da Nang was hit by the typhoon Nari, which made landfall in Danang and Quang Nam areas with a Category 1 level on 15 Oct. It is reported that there were 11 injuries, 122 houses collapsed, 5449 house damaged/unroofed, 13 public buildings damaged. Aside from floods and typhoons, Da Nang was also impacted by droughts, river–bank and coastal erosion, and saline intrusion. Under the impact of climate change, the city has taken many steps toward such as developing plan for CCE, carrying out teacher training, strengthening the physical conditions of the majority of its schools located in vulnerable areas. However, at school level, the School Management Board approach to the development plan for CCE, carrying out normal teaching program after the disasters. This result in educational interruption and affecting educational quality.

By giving the overall pictures of existing conditions of CCE in Da Nang, it provides important insights to enhance the implementation of CCE into school through integrated approach. The result from the study shows that a coalescence of three approaches including textbook driven approach, symbolic approach, and community-oriented approach will help to advance the level of CCE in Da Nang. The framework on how to consolidate these approaches in the application of CCE in school will be proposed.
local communities for protection of local ecosystems and its own health and budget. Why is this not being done or done insufficiently now? The reason, above all, in the absence of the local population aware that they can and should try to solve these problems themselves and to be able to raise these issues with the authorities. Mechanism for the implementation of this approach is to obtain the necessary information, the acquisition of relevant skills and knowledge. We offer that problems with training youth and adults can be solved not only at the state level, but also the help of local initiatives – at a local level, that under present conditions for developing countries more effectively. And, probably, it is necessary to begin from below – from family. Central research objectives - Identification of the potential for the implementation of an effective mechanism for improving local communities knowledge for adaptation to climate change. As a methodological tools used a public opinion poll, case study, a priori and statistical data, methods of observation; as one of the impact tools used brochure "Environmental safety of family and environment conservation". The case study include questions: 1. Identification of parameters (factors), climate change (oligohydramnios, drought, mudslides, avalanches, floods, land degradation, etc.) That affect the social aspects (function) – income, health, etc.; 2. Analysis of existing methods of mountain population adapting to climate change. 3. Identifying the needs of the knowledge and methods of influence. The next step of our research was to determine the feasibility of learning communities on an ongoing basis taking into account regional specificities. We analyzed a number of possibilities and we have offered cost-effective and accessible mechanism for improving local communities knowledge for adaptation to climate change. This experience can be disseminated and used in developing countries.
Tales of Future Weather

W. Hazeleger (1)
(1) Netherlands eScience Center/KNMI/WU, Amsterdam, Netherlands

Society is vulnerable to extreme weather events and, by extension, to human impacts on future events. As climate changes, weather patterns will change. The search is on for more effective methodologies to aid decision-makers both in mitigation to avoid climate change and in adaptation to changes. The traditional approach uses ensembles of climate model simulations, statistical bias correction, downscaling to the spatial and temporal scales relevant to decision-makers, and climate change scenarios. Such information is inherently difficult. The veracity of this approach cannot be tested, and it faces in-principle challenges. Predictability beyond weather time scales is limited, and physical consistency is often lost when downscaling. Alternatively, numerical weather prediction models in a hypothetical climatic setting can provide tailored narratives for high-resolution simulations of high-impact weather in a future climate. This is the ‘Tales of Future Weather’ approach. It will aid in the interpretation of lower-resolution simulations such as produced in the Coupled Model Intercomparison Projects (CMIP). At this presentation a number of real-world cases will be presented where vulnerability to meteorological conditions was exposed. These are typically high-impact, not necessarily extreme, weather events. For instance, compounded events of storm surges and severe rainfall in the mid-latitudes and of heat and drought in the subtropics. We will show how narratives of those analogues can describe the events in an alternative climatic setting to aid decision-makers. Producing the narratives is a transdisciplinary process where scientists and decision-makers co-develop the information needed. Arguably, ‘Tales’ potentially provides complementary, more realistic and more physically consistent pictures of what future weather might look like.

No-analogue Climate Futures in the Tropics

R. Corlett (1)
(1) Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences, Center for integrative conservation, Menglun, Mengla, Yunnan, China

Climatic extremes in the tropics—cyclones, floods, droughts, and heatwaves—currently kill tens of thousands of people a year, and damage or destroy the livelihoods of many others. Wild species are presumably adapted to these extremes and, although individuals are killed, their populations usually persist, except when natural weather extremes interact with land-use change and other human impacts to change fire regimes and exacerbate floods and droughts. Climate model predictions of a further 1–2°C warming by 2050 and 1–4°C by 2100 for the tropics, but less in the mid-latitudes, may lead to shifts of many others. Wild species are presumably adapted to these extremes and, although individuals are killed, their populations usually persist, except when natural weather extremes interact with land-use change and other human impacts to change fire regimes and exacerbate floods and droughts. Climate model predictions of a further 1–2°C warming by 2050 and 1–4°C by 2100 for the tropics, but less in the mid-latitudes, may lead to shifts of many others. Wild species are presumably adapted to these extremes and, although individuals are killed, their populations usually persist, except when natural weather extremes interact with land-use change and other human impacts to change fire regimes and exacerbate floods and droughts. Climate model predictions of a further 1–2°C warming by 2050 and 1–4°C by 2100 for the tropics, but less in the mid-latitudes, may lead to shifts of many others.

Future projection of precipitation associated with Cutoff Lows over South Africa in a Coupled Global Climate Model

A. Favre (1); C. Lennard (2); B. Hewitson (3); Y. Richard (1)
(1) Université de Bourgogne, Centre de recherches de climatologie, umr 6282 biogéosciences cns, Dijon, France; (2) University of Cape Town, Climate System Analysis Group, Cape Town, South Africa; (3) University of Cape Town, Environmental and Geographical Science, Rondebosch, South Africa

In South Africa, Cut-off Lows (CoLs) are known to be responsible for tempestuous weather and some remarkable precipitation events. This work presents how precipitation associated with CoLs may evolve in the region of South Africa in a context of global warming. Using the historical (1976–2005) and the Representative Concentration Pathway 8.5 (RCP8.5, 2006–2100) simulations of the Centre National de Recherches Météorologiques coupled global climate model (CNRM-CM5), the trajectories of 500–hPa CoLs have been constructed following the methodology presented in Favre et al. During the historical period, we find that the geographical and seasonal distributions of CoLs’ frequency over South Africa and surrounding oceans are well simulated by the CNRM-CM5. In addition, the main observed features of precipitation associated with CoLs are correctly reproduced by the model. According to the RCP8.5 simulation, drier conditions are projected over South Africa by the end of the 21st century and the CNRM-CM5 also presents a general decrease in annual precipitation, except over the plateau in the Northern Cape province. Precipitation associated with CoLs is projected to decrease excepted over the Northern Cape where heavy and extreme precipitation days (RR > historical 75th percentile and RR > historical 95th percentile, respectively) attributed to CoLs may be more frequent. These changes are associated with a slight reduction of CoL annual frequency of and with a slight equatorward shift of their domain of occurrence in the studied region. Over the 21st century, these changes are expected to develop in parallel with decadal variability and with an increase in the interannual variability of CoL’s frequency.

Polar lows and Medicanes: Understanding how intense mesocyclones and their impacts might respond to climate change

S. Len (1)
(1) NCAS–Climate, Department of meteorology, Reading, United Kingdom

Polar Lows and Medicanes are very intense, small cyclones that occur in the Norwegian and the Mediterranean Seas. Although small in size, Polar Lows and Medicanes can generate damaging winds that have substantial impacts on shipping, coastal communities and infrastructure. Polar Lows and Medicanes have very symmetric structures, often having a central eye-wall that has led to them being referred to as Arctic Hurricanes and Mediterranean Hurricanes. Polar Lows and Medicanes are too small to represent in typical climate models. This means that there are very large uncertainties in how Polar Lows and Medicanes will respond to climate change, despite their large socioeconomic impacts.

This talk will discuss progress in simulating Polar Lows
and Medicines in global climate change simulations performed at very high resolutions. The results of historical and climate change simulations with a 25km resolution version of the HadGEM3 climate model will be presented. The HadGEM3 simulations suggest that the frequency of both Polar Low and Medicines will decrease under climate change, primarily due to increases in the stability of the atmosphere over the Norwegian and Mediterranean Seas. However, there are some indications that when they do occur Polar Low and Medicines may become more intense in a warmer climate. The potential for improving climate model projections of Polar Laws and Medicines will also be discussed.

O-2201-03
Forecasting heavy precipitation producing cyclones in the island of Crete
L Tsanis (1)
(1) McMaster University, Civil Engineering, Hamilton, Ontario, Canada
The intensification of the hydrological cycle due to climate change will produce intense meteorological events, causing higher precipitation in shorter time periods. The island of Crete is located in the Eastern Mediterranean and is prone to such events which are a cause of increased risk of flash flooding. The objective of this study is to obtain a better understanding of the hydrometeorological processes that produce heavy precipitation in the island of Crete and the correlation between precipitation and synoptic conditions. Effective flood risk management for these natural disasters will increase public safety by reducing fatalities and changing the policy for a better flood risk management plan. For this purpose, images from the Meteosat Meteorological Images (Infra-Red IR-10.8, 3h); (b) Mean Sea Level Pressure ERA Interim (6h); (c) Wind at 500 hPa from ERA Interim (6h); (d) Vorticity at 500 hPa from ERA Interim (6h); (e) Lightning (USNL Lightning Network – 3h) and (f) Heavy precipitation from Crete Meteorological Stations (3h). At present, the data from the 15-17th of November 2010 storm event has been analyzed. In this event, one of the precipitation stations located in the northwest part of the island of Crete, recorded more than 100mm of rain on 16/11/2012 and about 45mm of rain in the following day. More specifically, on 16/11/2012, 56.6mm of rain fell within one hour (14:00—15:00 UTC), and 27mm of rain on 17/11/2012 between 14:00—15:00 UTC. This severe rain event was caused by a cyclonic system approaching Crete from the Atlas Mountains, entering the Mediterranean on 15/11/2012, and moving to the east, with its center being located south of Crete. The spatio-temporal distribution of the relative vorticity, wind speed, mean sea level pressure, lightning and the time of precipitation are used to shorten the forecasting time of a heavy precipitation event, in a probabilistic sense. More cases will be analyzed and presented in the conference, in order to validate the forecasting precipitation results in terms of sensitivity, specificity and accuracy.

O-2201-04
Expansion of the tropics: evidence and implications
S. Turton (1)
(1) James Cook University, College of Marine & Environmental Sciences, Cairns, Australia
There is accumulating evidence that the tropical zone is expanding poleward in both hemispheres. The implications of a poleward tropical expansion are significant; sub-tropical, arid, conditions may be seen in regions at higher latitudes which have historically enjoyed a more temperate climate, with implications for management of water resources and agricultural systems. However, some regions which currently border the equatorial zone may experience an increase in extreme rainfall, which could result in flooding, the displacement of communities, and loss of lives. The expansion of the Tropics may be linked to a concomitant expansion in the tracks of tropical cyclones, potentially bringing cyclonic activity to regions which have previously not experienced such weather events. Changes to the tracks and activity of cyclones, and other extreme weather events, will impact on human health, biodiversity and the economy. The burden of vector-borne diseases on health and the economy of the Tropics may also increase as more regions become climatically suitable for insect vectors. The Tropics are the most biodiverse region on earth, with more endemic species and more biodiversity ‘hotspots’ than anywhere else. However research suggests that although many species are tracking climate changes, species in the Tropics may be lagging behind the rate of tropical expansion – meaning some species may not be able to sufficiently track their preferred environment and climate and may potentially risk extinction. This paper explores the implications of tropical expansion for societies and environments in the tropics, who are likely to experience futures with no precedence.

P-2201-01
Assessment of Southwest Asia Surface Temperature Changes: CMIP5 20th and 21st Century Simulations
Z. Babar (1); XF. Zhi (2); G. Fei (2)
(1) Nanjing University of Information Science and Technology, College of international students, Nanjing, China; (2) Nanjing University of information Science and Technology, Nanjing, China
Surface temperature variability in southwest Asia from CMIP5 20th century simulations and projected changes under three emission scenarios for the 21st century are assessed in this study. Results are obtained from mean of seventeen CMIP5 runs and two observational datasets. Performance of individual model is also computed. Compared with observations CMIP5 models show seasonality in biases over southwest Asia. Cold biases over Himalayan range are significant in winter than in summer. Climatic warming during the 20th century is very well captured by the CMIP5 models. There is a limited agreement among the observations and CMIP5 models ensemble mean regarding the temperature trends and their spatial distribution over southwest Asia. Surface temperature variability over southwest Asia is best represented by three individual models i.e. BCC-HadGEM and NorESM. Temperature projections for the 21st century demonstrate that annual temperature rise for RCP 8.5 and RCP 4.5 scenarios is 0.55°C (10 year) and 0.27°C (10 year) respectively. The 21st century average annual mean temperature in southwest Asia is estimated to increase by 0.80°C to 4.85°C. Most of this warming is projected to take place around Pakistan and its surrounding areas.

P-2201-02
Investigation of uncertainty in the IPCC AR5 precipitation and temperature projections over Iran under RCP scenarios
N. Ghahreman (1); M. Tabatabaei (2); I. Babaeean (3)
(1) University of Tehran, Irrigation and Reclamation Engineering, Karaj, Islamic Republic of Iran; (2) University of Tehran, Irrigation and reclamation engineering dep., Alborz, Karaj, Islamic Republic of Iran; (3) Climatological Research Institute, Mashhad, Islamic Republic of Iran
Upon release of new scenarios based on Radiative Forcing which are known as Representative Concentration Pathway scenarios (RCP scenarios), by Intergovernmental panel on climate change (IPCC) and the Intergovernmental Panel on Climate Change (IPCC), a new set of 42 global climate models (GCMs) have been proposed for future climate projections. By increasing number of available models for running and application to 42 RCP scenarios, it is believed that a better estimation of uncertainties is possible. The main aim of this study is to investigate the uncertainty of outputs of 37 Coupled Model Intercomparison Project Phase 5 (CMIP5) for precipitation and temperature data in Iran. Required data consist of two main groups: Simulated historical data and Observations. The observed data of rainfall and temperature were retrieved from three sources. Two databases namely, Climatic Research Unit (CRU) and NCEP/NCAR Reanalysis Project, and selected synoptic stations over Iran. Comparisons were made between the data reported in the climatic databases and those observed in synoptic stations using Root Mean
The timing of summer climate departure in cities and its lethal impact

C. Mora (1); D. Boussset (2); C. Trauernicht (3); I. Caldwell (4); Q. Chen (1); C. Dau (1); B. Dietrich (5); R. Fang (1); R. Geronimo (1); E. Johnston (6); L. Li (7); M. Lucas (3); M. Mckenzie (1); F. Powell (1)

(1) University of Hawai’i at Manoa, Department of geography, Honolulu, United States of America; (2) University of Hawai’i at Manoa, Hawai’i institute of geophysics and planetology, Honolulu, United States of America; (3) University of Hawai’i at Manoa, Department of natural resources and environmental management, Honolulu, United States of America; (4) University of Hawai’i at Manoa, Hawaiian institute of marine resources, Honolulu, United States of America; (5) University of Hawai’i at Manoa, Department of plant and environmental protection sciences, Honolulu, United States of America; (6) University of Hawai’i at Manoa, Department of botany, Honolulu, United States of America; (7) University of Hawai’i at Manoa, Department of atmospheric sciences, Honolulu, United States of America

Climate models for the 21st century predict a year-to-year variability in summer temperatures that lead to a significant increase in the occurrence, intensity, and duration of heat waves. These are especially deadly in urban areas that account for half the world population and are characterized by heat island effects, production of anthropogenic heat, and aging inhabitants. We investigated the projected times after which mean summer climate in large cities will shift beyond historical values, generating environmental conditions that will endanger human health. Data on urban extreme heat events and their related mortality during 1980–2010 were collected from an extensive literature review and relevant websites. When mapped, these data are predominantly distributed in the mid-latitudes, indicating either a more intense warming or a lack of available data in tropical regions. Climate variables and time of occurrence were extracted from actual data to identify the set of conditions that exceed human tolerance to extreme heat events. These thresholds were then combined with Earth System Models of the Coupled Model Inter-comparison Project phase 5 using different Representative Concentration Pathways (RCPs 2.6, 4.5, 8.5) to estimate the timing of lethal climates. Results indicate a strong association between climate anomalies and fatal weather events in the past and suggest that such events will occur periodically in all the largest cities of the world. Although it is possible that human adaptation and resilience to these events may help reduce mortality, it is clear that ongoing climate change will pose a threat to human survival over vast areas of the world. The foreseeable urban summer climate departures call for a global and substantial reduction in greenhouse gas emissions. They also prompt for local implementation of sustainable mitigation strategies and for public health actions in order to reduce the lethal impact of climate change.

Between the mazes of Climate Scenarios

B. Van Den Hurk (1)

(1) KNMI, Model Development, De Bilt, Netherlands

Climate scenarios, such as those prepared for the Dutch Climate Adaptation program, are useful instruments to cast a large collection of possible future evolutions in a generic reference framework. But these scenarios necessarily only describe the bigger picture, and miss the elementary details that govern every-day decision making. Challenging events are governed by a mixture of weather phenomena, infrastructure design, preparedness on the ground and compounding features. Here we illustrate a number of approaches relying both on past events and (synthetic) future weather cases that can provide the necessary additional “real life” material that is needed to support informed decision making.
This keynote talk will present results from the UK AVOID programme, which is concerned with both identifying and quantifying impacts of climate change under different pathways and assessing the technical and economic feasibility of these pathways. The focus of this presentation is on the impacts avoided and delayed by climate mitigation. It considers global and regional impacts of or contributors including water resources, flooding, agriculture and energy demand, and evaluates how these impacts are affected – globally and regionally – under different mitigation pathways. The effects of climate change mitigation policy are expressed in terms of the magnitude of impact and the risks of impacts exceeding specific thresholds.

The presentation concludes by reviewing the key issues involved in assessing the implications of climate mitigation policy for impacts, which include the representation of adaptation within global-scale impact assessments, the treatment of uncertainties, and the prefiguration of results in terms meaningful to climate policymakers and negotiators.

K-2202-03

Visions of Global Responses to Climate Change - Lock-in and Transformation

J. Dangerman (1)

(1) Potsdam Institute for Climate Impact Research, Potsdam, Germany

This keynote will discuss the central dynamics of complex systems that determine change and lack of change. Or, in more specific terms, that determine transformation and lock-in. It will also present a case that illustrates these dynamics and their effects in practice.

Important portions of yesterday’s and today’s socio-technological-political decisions extrapolate the past into the future and thereby profoundly constrain the possibilities of important systems to transform themselves non-catastrophically so that they can help mitigate their current and future effect on climate change and the economic and social impacts on humanity. The transpiration rigidification of these systems is eminent from essential perspectives and in fact provides grounds for structural alternative decisions. However, the constraints caused are often underestimated and misinterpreted and the accompanying alternative decisions are frequently not so profoundly breaking with the past. The development of a key actor in climate change, the global energy system, provides ample examples of these instances and on a macro-scale shows the ensuing lock–in patterns.

This keynote therefore provides a simple and stylised view on the universal working of the fundamental dynamics that determine the behavior of evolving complex systems, such as cells, the human brain, organisms, organisations, technologies, societies and economies. It uses the concepts of effectiveness & efficiency and chaos & organisation in the context of the cyclical and periodical behaviour of these systems to explain the dynamics of both transformation and lock–in.

It ends with a discussion of a research case about the role of energy efficiency policies in the building industry (called «Best Practice Policies for Low Carbon & Energy Buildings Based on Analogies», authored by the model For Climate Change And Sustainable Energy Policy, Central European University) to elucidate the lock–in dynamics, their consequence and their implications for policy making. Three scenarios explain the potential for the buildings sector to mitigate energy consumption in China, the EU, India and the USA. The most ambitious scenario shows the benefit and necessity of taking today’s best practice to a global scale.

O-2202-01

Hydrological variability, transboundary floods and institutions: an exploration of tomorrow’s bottlenecks

M. Bakker (1); J. Duncan, (2)

(1) Utrecht University, Utrecht, Netherlands; (2) University of Vermont, Vermont, United States of America

Floods are among the world’s most frequent and damaging types of disasters and annually affect the lives of millions all over the globe. Over time, human exposure and vulnerability to floods has increased with a growing and increasingly urbanized population. The projected effects of climate change, with ever increasing vulnerability, will be accentuated by a range of social, economic and political processes which will continue to increase this vulnerability. Nonetheless, vulnerability of societies and their institutions to floods remains poorly understood.

Purpose

Using global data, we examine the nexus of transboundary floods, event severity and social vulnerability: which international river basins (IRBs) have experienced transboundary floods, i.e. floods that affect two or more countries, in the past, and which are forecast to experience increased hydrological variability in the future, but lack institutional provisions, i.e. river basin organizations and/or treaties, to deal with these shared events?

Methodology

Current data and research on institutional capacity deriving from treaties as listed in the Transboundary Freshwater Dispute Database (Yoffe, Ward and Wolf, 2000; De Stefano et al. 2012) will be refined by looking more specifically at the role that river basin organization functioning and treaty composition play in flood management. IRBs will be stratified by the type stress they may face in terms of hydrological change and the aspects of society most affected by flooding. Then, this updated information will be merged and weighted to produce a vulnerability ranking specific to floods and the institutions designed to manage them.

Results and conclusions

A global vulnerability ranking of IRBs and cities when it comes to transboundary floods, climate–driven hydrological variability and institutional capacity.

Societal relevance

The findings of this research will significantly increase our current knowledge on transboundary flood events, projected variability regimes related to the shared waters between countries, and flood–related international institutional capacity. These insights will help policymakers of tomorrow identify and evaluate potential tipping points related to transboundary river floods.
global crop production. We find increasing, and in many cases accelerating risk, of extreme global loss events even in scenarios with little to no climate-induced long-term mean changes. In some cases, global-scale production loss events that would have recently been called 1-in-100 year events are estimated to occur every 30 years by mid-century, and every 10–20 years by end-of-century.

We present these scenarios and consider regional and global protective measures that might be introduced, including increased trade, stock-hoarding, crop breeding, and improved forecasts, monitoring, and modeling. We also consider the extent to which aggressive carbon mitigation may decrease the risk of extreme loss events in future.

O-2202-03
Climate indicators of pace and perception of changes over the 21st century
Y. Chavaillaz (1) ; S. Joussaume (1) ; S. Bony (2) ; P. Braconnot (1) ; R. Vautard (1)
(1) LSCE-IPLS, Gif-sur-Yvette, France; (2) LMD-IPLS, Paris, France

In most studies, climate change is approached by focusing on the evolution between a fixed current baseline and a future period. They emphasize stronger warming and increasingly modified precipitation patterns as we move further from the current climate. This long-term vision is adopted in order to characterize quantitatively the magnitude and expected effects of mitigation policies across the globe, but is not well suited to discuss coming generations’ experience. In this study, we propose an alternative approach that considers indicators of pace and perception of changes using projections of a General Circulation Model ensemble. It first consists in tracking statistics and their projected changes with a 20-year running baseline, defining the time evolution of the pace at which climate changes on the scale of a generation. Then, distributions of the following and previous 20 years are compared for each year to theoretically assess the change. We consider the annual and seasonal evolution of surface air temperature and precipitation.

Under the strongest emission pathway (RCP8.5), the warming rate and its perception become far stronger over the 21st century, with a maximum reached around 2060. While northern high-latitude regions remain the highest value in the tropics, especially in West Africa and South-East Asia. As for precipitation change, we find that regions that are already wet get wetter and regions that are already dry get drier.

These trends are already visible in the current period, but could only disappear if strong mitigation policies were quickly implemented. Only the strongest mitigation pathway (RCP2.6) leads to a global return to historical regime. This approach shows that, under strong emissions, one should be prepared for higher adaptation rates in the coming decades regarding temperature and precipitation change.

2020–POSTER PRESENTATIONS
P-2202-01
Mitigation and Adaptation are not enough: turning to emissions reduction abroad
A. Ayong Le Kama (1) ; A. Pommeret, (2)
(1) EconomiX, University of Paris West, Nanterre - La Défense, Nanterre, Cedex, France; (2) School of Energy and Environment, City University of Hong Kong, G5702, S/F, Academic 1, Tat Chee Avenue, Kowloon, Hong Kong

In this paper we focus on a long-term dynamic analysis of the optimal adaptation/mitigation mix in the presence of a pollution threshold above which adaptation is no longer efficient.

We account for accumulation in abatement capital, greenhouse gases, and adaptation capital in order to better capture the arbitrage between abatement and adaptation investments.

Pollution damages arise from the emissions due to the country consumption but also from the emissions of the rest of the world (ROW).

A pollution threshold is then introduced, above which adaptation is no longer efficient. We obtain that if this threshold is lower than the steady-state level, there is no way for the modeled economy to avoid it. In particular, such a situation will appear if the ROW’s emissions are high.

Next step is then to introduce another type of investment allowing for lower ROW pollution i.e. emissions reduction abroad through some mechanisms like CDM for instance. We obtain that CDM may be a means to avoid a pollution threshold above which adaptation becomes of no use.

P-2202-02
Two degrees or not two degrees: that is the question – interim results from ICA-RUS project
S. Emori (1) ; T. Kiyoshi (1) ; Y. Yamagata (1) ; S. Kanae (2) ; S. Mori (3) ; Y. Fujigaki (4)
(1) National Institute for Environmental Studies, Tsukuba, Japan; (2) Tokyo Institute of Technology, Tokyo, Japan; (3) Tokyo University of Science, Department of Industrial Administration, Noda, Chiba, Japan; (4) The University of Tokyo, Tokyo, Japan

Politically, the long-term target of climate change might not actually be a question at this moment. However, we have to repeatedly ask ourselves the question – whether it should really be “two degrees” and why – to ensure that the target is kept transparent, responsible and relevant.

We have tackled this issue from a risk management perspective in an interdisciplinary research project, called the Integrated Climate Assessment – Risks, Uncertainties and Society (ICA-RUS) since 2012, funded by the Ministry of the Environment, Japan. It has tried to integrate insights from the areas of climate risk assessment, energy economics modeling, energy–water–food–ecosystem nexus, and STS (science, technology and society). By a risk management perspective, we mean that the problem is framed as an informed, adaptive decision making under uncertainties (potentially including deep uncertainties), involving social value judgment.

We have supposed three “Alternatives left to humanity” represented by mitigation targets, 1.5, 2.0 and 2.5 degrees C, below which humanity tries to keep the global mean temperature increase relative to pre-industrial levels at a probability of 50% (which roughly translate into 2.0, 2.5 and 3.0 degrees C targets at a higher probability like 80%).

For each alternative mitigation target, potential consequences have been assessed for various sectors including disastrous weather events, water resources, agriculture, health, ecosystems and tipping elements. The potential consequences are represented by a range taking into account uncertainties in climate, mitigation and socio–economics. Thus, for example, even if 2.0 degrees C target is set, the potential consequence includes a 3.0 degrees or higher global mean temperature increase associated with corresponding impacts, due to various kinds of uncertainties.

At the same time, possible combinations of mitigation options and associated mitigation costs have been assessed for each mitigation target with multiple energy economics models with different modeling assumptions. Various risks and opportunities (side–effects and co–benefits) associated with each mitigation option are also kept in mind.

Putting these assessments together, the project is currently in the process of characterizing the risks to be reduced and to be retained for each “Alternative” (i.e., each mitigation target). As a next step, adaptation effort needed
ABSTRACT BOOK

International Scientific Conference 7-10 JULY 2015 PARIS, FRANCE

P-2202-03
Modelling ecosystem response to present and future drought events in Western Europe with the CARAIB dynamic vegetation model

A. J. Henrot (1); M. Dury (1); A. Hambuckers (2); G. Munhoven (3); I. Jacquemin (1); L. François (1)
(1) Unité de Modélisation du Climat et des Cycles Biogéochimiques, Département d’arthropsthique, de géophyse et d’océanographie, Liège, Belgium; (2) Biologie du Comportement – Ethologie et psychologie animale, Département de biologie, écologie et évolution, Liège, Belgium; (3) Laboratoire de Physique Atmosphérique et Planétaire, Département d’arthropsthique, de géophyse et d’océanographie, Liège, Belgium

With unprecedented speed and extent, future climate change can be expected to severely impact terrestrial ecosystems due to more frequent extreme events, such as droughts or heat waves. These extreme events might lead to severe impacts on terrestrial plants functioning, implying reduction in net primary production and possibly plant mortality in many regions. The Inter–Sectoral Impact Model Integration and Intercomparison Project (ISI–MIP) has been explicitly designed to evaluate the models’ ability to reproduce observed historical variability, and response to present–day and future extreme climatic events, reflecting the interest of the community as well as stakeholders in this particular topic.

In this contribution, we analyse the results over Western Europe of the ISI–MIP2 simulations performed with the CARAIB dynamic vegetation model (Dury et al., 2011, iForest 4, 82–99), for a series of well–marked drought events in the simulated historical and future periods. This analysis is performed at the species level, using a set of 99 species (47 herbs, 12 shrubs and 40 trees), especially designed to represent the European vegetation. Model response to drought events is evaluated in terms of several important environmental variables, such as soil water and hydric stress, runoff, PFT/species abundance, net primary productivity and biomass, fire frequency, and turnover of soil organic matter. Some sensitivity tests are performed to study the impacts of changing some not well–constrained model parameters, such as thresholds and response times for plant mortality induced by soil water stress.

P-2202-04
When can we expect to see the benefits of climate mitigation?

B. Sanderson (1); B. O’Neill (2); C. Tebaldi (3); G. Strand (4)
(1) NCAR, Climate Change Research, Boulder, CO, United States of America; (2) National Center for Atmospheric Research (NCAR), Boulder, CO, United States of America; (3) NCAR, CGD, Boulder, CO, United States of America; (4) NCAR, Boulder, United States of America

We present a 20 member ensembles of possible future climate using a single climate model, CESM, to assess the question of when climate mitigation action becomes evident in the presence of irreducible internal climate variability. Our business–as–usual and mitigation ensembles assume the RCP8.5 and RCP4.5 scenarios respectively, and we find that although internal variability causes a comparable uncertainty to the differences in forced climate response until 2050, significant differences between RCP8.5 and RCP4.5 are evident in as early as 2025 in the two scenarios for some regions (and for most regions by 2040). Furthermore, the following decades from 2050–2080 see largely separate temperature distributions in the two ensembles for most regions, although we do not see significant differences in precipitation between the two scenarios even for periods after 2060. Hence, in the CESM’s representation of the Earth System for the latter portion of the 21st century, the risks of impacts related to temperature extremes in the next 20 years can be significantly reduced by greenhouse gas mitigation, even in the presence of internal climate variability.

P-2202-05
Influence of Water Resource Management on Altering Hydrological Drought under Climate Change

Y. Satoh (1); K. Yoshimura (2); P. Yadu (3); H. Kim (4); T. Oki (5)
(1) International Institute for Applied Systems Analysis, Water, Laxenburg, France; (2) The University of Tokyo, Atmosphere and ocean research institute, Kashiwa, Japan; (3) Rutgers, The State University of New Jersey, Camden, United States of America; (4) The University of Tokyo, Institute of industrial science, Tokyo, Japan; (5) University of Tokyo, Tokyo, Japan

It is expected that global warming alters hydrometeorological cycle and influences on occurrence of drought. Future drought is projected to increase with high probability in some regions, such as the Mediterranean region, the west side of USA and so on, resulting in severer water scarcity. Nevertheless only few studies have investigated the effect of planned water management, such as dam regulation and irrigation, against drought. Understanding of the effect of existing infrastructures under changing water–environment is needed for our society to adapt to future climate changes. Therefore, this study aims to estimate the effect of the anthropogenic activities on terrestrial water cycle as well as the impacts of climate changes.

This study focuses on hydrological drought, particularly on stream drought. HiGW–MAT, a state of arts land surface model capable to reproduce energy and water cycle considering the anthropogenic water management, was used to simulate historical and future terrestrial water cycle under RCP scenarios. Five bias–corrected CMIP5 GCM outputs provided by ISI–MIP fast track for 1980–2099 were used to force a set of simulations.

Future drought was projected, and hot spots of climate change impact were detected with uncertainty discussion. It was found that number of hydrological drought days would increase and decrease over approximately 70 % and 25 % of global land. Increase of drought days in the first half of 21th century is larger than that of the second half in 19 out of 26 regions of IPCC regional classification. The effect of anthropogenic water management is depicted as a difference between simulations with and without anthropogenic components. As for time series variation, the difference showed that both of short–term variation and long–term change are alleviated by introduction of water management, though it was also suggested that exploitation of water from river due to water use accelerates drought. This model exercise presents a valuable preliminary evaluation of human impact for the purpose of planning of more practical assessment which provides optimal water management scenarios.
2203 - Defining dangerous climate change: Contributions from the AR5 ‘Key Risks’ and ‘Reasons for Concern’ frameworks and future directions

ORAL PRESENTATIONS

K-2203-01

The IPCC Reasons for Concern: History, current status, and future directions

B. O’Neill (1)
(1) National Center for Atmospheric Research (NCAR), Boulder, CO, United States of America

The Reasons for Concern (RFCs) framework, developed in the Third Assessment Report (TAR) of the Intergovernmental Panel on Climate Change (IPCC), organizes scientific information to inform decisions relevant to implementation of Article 2 of the UN Framework Convention on Climate Change (UNFCCC). Article 2 contains the Convention’s long-term objective of avoiding “dangerous anthropogenic interference with the climate system”. The framework facilitates judgments about changes in impacts, risks, and vulnerability as a function of global mean warming by sorting and aggregating them into five categories viewed from a global perspective. The RFC framework and the associated “Burning Embers” diagram illustrating these judgments have been widely discussed and applied. We sketch the history of the use of the RFC framework in IPCC assessments and describe refinements made for the recent Fifth Assessment Report (AR5). In AR5, the RFCs were reframed to define all five categories in terms of risk. In addition, a more consistent approach to judging risk was used that was linked to the concept of Key Risks that was used across much of the Working Group 2 report. We also illustrate how risk judgments are grounded in the scientific literature and highlight remaining challenges to making such judgments. Useful improvements to the RFC framework include better accounting for alternative metrics of climate change beyond the level of global average temperature change, explicit incorporation of the future vulnerability of society and ecosystems, and better communicating the specific risks over which RFC categories aggregate.

K-2203-02

Reasons For Concern as a Tool for Assessing Dangerous Climate Change and their Utility for Climate Negotiations

L. Charles (1)
(1) Charles & Associates, Inc., St. George’s, Grenada

The Reasons for Concern framework has been used by the IPCC to communicate its results to policy makers in a policy informative, but not policy prescriptive manner. It assesses the risks in light of the UNFCCC Article 2 – to avoid dangerous interference with the climate system – by presenting a continuous representation of how key risks change with temperature rise. The framework has been used in the UNFCCC negotiations as one of the key inputs to the process of the 2013-2015 review of the adequacy long-term global goal under the UNFCCC. Key issues that I will explore in this context are (a) how well does the RFC framework capture impacts on ecosystems, food production and sustainable development? and (b) The extent of its use in the UNFCCC review, the results obtained from its use and the utility of these results.

From a policy perspective, the RFC framework has approached the analysis of these risks through a global lens. However, policy responses to these risks take place at the national and regional levels, primarily through adaptation action. It is therefore very relevant to also review the framework’s applicability in informing policy at the national and regional levels. This will be done from the perspective of Small Island Developing States (SIDS).
O-2203-02

Measuring the dynamics of risks at the global and local level: information for transformative change

J. Birkmann (1); T. Welle, (1); W. Solecki (2); M. Garschagen, (3); M. Pelling, (4); J. Agboola, (5)
(1) Institute for Spatial and Regional Planning, University of Stuttgart, Stuttgart, Germany; (2) CUNY Institute for Sustainable Development, New York City, United States; (3) United Nations University, Institute for Environment and Human Security, Bonn, Germany; (4) King’s College London, Department of geography, London, United Kingdom; (5) Lagos State University, Lagos, Nigeria, Federal Republic of

Key risks identified in the IPCC AR5 encompass various themes and dimensions. However, all these risks underscore the influence of climate change on hazards and the significance of exposure and vulnerability as determinants of risk. Based on selected risks identified in the AR5, trends towards policies for stability (resistance) or flexibility to protect existing core functions (resilience) are shown that underscore the importance of exposure and vulnerability as determinants of risk. Based on selected risks identified in the AR5, trends towards policies for stability (resistance) or flexibility to protect existing core functions (resilience) are shown that underscore the importance of exposure and vulnerability as determinants of risk. Based on selected risks identified in the AR5, trends towards policies for stability (resistance) or flexibility to protect existing core functions (resilience) are shown that underscore the importance of exposure and vulnerability as determinants of risk. Based on selected risks identified in the AR5, trends towards policies for stability (resistance) or flexibility to protect existing core functions (resilience) are shown that underscore the importance of exposure and vulnerability as determinants of risk. Based on selected risks identified in the AR5, trends towards policies for stability (resistance) or flexibility to protect existing core functions (resilience) are shown that underscore the importance of exposure and vulnerability as determinants of risk.

The second part of the paper examines risk configurations at the local level and the interaction of risk profiles for selected, large scale, coastal cities. Coastal cities are at the forefront of living with climate and socio-economic change. Existing adaptation and development visions that address key policy trends towards policies for stability (resistance) or flexibility to protect existing core functions (resilience). There is increasing recognition in the academic literature that a policy trend towards policies for stability (resistance) or flexibility to protect existing core functions (resilience) is needed in order to address key determinants of the key risks also named in the AR5. Against this background changes in local risk profiles and risk trends are examined and specific policy options to mitigate climate change risks are discussed. This presentation draws from a Belmont Forum funded study, Transformation and Resilience on Urban Coasts (TRUC), that examines five coastal megacities to begin to profile transformative options based on the assessment of dynamics of hazards, exposure and vulnerability to climate change related risks.

Concrete examples of past and present risk patterns are presented using the case studies of New York and Lagos. In addition, methods and results of new scenario techniques are shown. Challenges to future pathways of exposure and vulnerability next to climate change scenarios. Differences and synergies between quantitative and qualitative scenario techniques will be discussed at the local level. After this conclusion, we formulate recommendations on how to use this information on changing risk profiles for promoting resilience and transformative change at local level focusing on policy options for adaptation in the two case studies.

O-2203-03

Downscaling the “Reasons for Concerns” to the Local Government Level as a Prerequisite for Tailored Adaptation and Disaster Risk Reduction – A Case Study from Austria

AM. Hama (1); I. Anders, (2); A. Baumgarten, (3); H. Berthold, (3); B. Eder (1); A. Felderer, (4); O. Fritz, (5); R. Jandl (6); M. Keuschning, (1); S. Kienberger (7); M. Leitner (4); M. Malek, (4); R. Mechler, (8); Z. Malek, (8); R. Pay, (8); I. Meyer, (5); I. Offenthaler, (5); A. Felderer, (4); O. Fritz, (5); R. Spiekermann, (7)
(1) alpS Centre for Climate Change Adaptation, Innsbruck, Austria; (2) Zentralanstalt für Meteorologie und Geodynamik (ZAMG), Vienna, Austria; (3) Austrian Agency for Health and Food Safety (LAGES), Austria; (4) Austrian Climate Research Agency Austria, Vienna, Austria; (5) Austrian Institute of Economic Research (WIFO), Vienna, Austria; (6) Austrian Research Centre for Forests, Vienna, Austria; (7) University of Salzburg, Department of geoinformatics – ZGIS, Salzburg, Austria; (8) International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria

IPCC’s Burning Embers – Reasons for Concern illustrate the future global risk development split into five categories and visualize the trends. To date, this holistic concept has not been transferred to the local government level where risk assessments and research are conducted. This paper will highlight and analyze the trends and visualize the consequences. The key concept of climate change related risks will be explored using the local level risk studies. In the project ARISE (Adaptation and Decision Support via Risk Management Through Local Burning Embers) funded by the Austrian Climate Research Program, closing this gap is a research focus, and a decision support system for climate-sensitive iterative risk management as a key adaptation approach is developed. The City of Lienz in East Tyrol, Austria serves as a pilot site for ARISE. The project’s overall objectives are (i) to contribute to identifying and bridging the gaps between global frameworks, research and policy related to climate change and disaster risk reduction and national, subnational as well as local risk management and adaptation needs and requirements by coupling and integrating information across scales, (ii) to downscale the “Burning Embers – Reasons for Concern” to the local level (LBE) with respect to hazard types and sectors including a consideration of key risk drivers, and (iii) to support the building of resilience and adaptation capacities at the local level via an LBE-integrated, iterative risk management approach that takes participatory processes and learning from practitioners into account.

In order to meet the project’s objectives, user-oriented methods in the form of hybrid techniques (top-down and bottom-up), monitoring and evaluation, participatory, modelling and mapping, are used. To date, interviews with various stakeholder groups have been conducted and a comprehensive desk review on global, regional and national frameworks has been completed. Based on the LBE-integrated, iterative scenario framework to the study site, regional climate scenarios for the City of Lienz have been computed. Further methods for determining the LBEs include the building of regional socio-economic scenarios by focusing on region-specific knowledge and visions (by means of a scenario workshop), supported by regional economic modelling. Moreover, a land-use scenario is being developed and indicators have been determined that also take confidence levels into account. In order to integrate the LBEs into the local risk management and risk management practices, a collaborative approach will be taken again, test runs will be conducted as well as a monitoring-evaluation concept devised. All information and processes will be fed into a dynamic risk information tool. The decision support system for climate-sensitive iterative risk management will be standardized to enable a wider application and roll-out.

In this presentation, an overview of the ARISE project and its concept will be given. The generic framework as well as the specific application to the City of Lienz will be presented and challenges discussed. Additionally, an outlook on the next steps and expected findings to be obtained through the integration of the LBEs with risk management and adaptation strategies will be provided.
A regional differentiation of climate impacts at warming levels of 1.5°C and 2°C

CF. Schleussner (1); T. Lissner (1); J. Wohland (2); E. Fischer, (3); K. Frieler, (4)
(1) Climate Analytics, Berlin, Germany; (2) Postdam Institute for Climate Impact Research, Potsdam, Germany; (3) ETH Zurich, Zurich, Switzerland; (4) Potsdam Institute for Climate Impact Research, Potsdam, Germany

Article 2 of the UNFCCC specifies that the aim of the convention is the “stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system”. Limiting global mean warming below 2°C increase above pre-industrial levels has been widely accepted as a global goal in this context. However, many vulnerable countries, particularly small island developing states and least developed countries, have questioned whether this limit is sufficient to protect their interests, and as a consequence there is an international process underway to evaluate risks and damages at different levels of warming, including 1.5°C and 2°C. Studies of current and expected future impacts of climate change suggest that significant negative impacts, relevant to Article 2 of the UNFCCC may be felt at lower levels of warming than 2°C. Within the UNFCCC there is a formal process reviewing the 2°C limit, and examining the possibility of changing it towards 1.5°C.

At present there is a gap in the scientific literature and methods to rigorously and qualitatively assess differential impacts at these levels of warming. Here we present a framework that allows for a differentiation of regional changes in climate impacts at different levels of global mean temperature (GMT) increase, focusing on the differences between 1.5°C and 2°C. Based on data from the CMIP5 archive as well as output from the ISIMIP project, we assess the climate impact projections for the 26 world regions used in the IPCC SREX report. We show results for several extreme event indices as well as projections of water availability and agricultural yields. Furthermore, we are able to test for statistical significance of changes in climate impact projections between the different warming levels across the model ensemble.

As climate impacts are not necessarily linear, it is important to understand whether a significant shift in the magnitude of impacts may occur between the different temperature levels and little attention has been given to such a shift. For instance, the consequences of average global temperature increase are not linearly distributed across regions. A differentiation of the spatial manifestation of change is therefore of high relevance for regional planning, in order to develop suitable coping strategies and adaptation options, as well as to inform decisions about the appropriate long-term global temperature goal.

Defining dangerous climate change in accordance to international law: What is and is not “dangerous” and how to define “dangerousness”? International standards for certain basic considerations for “policy-makers”, “policy-takers”, scientist and jurists

S. Pena (1)
(1) Universidad Bernardo O Higgins, Law and Environment, Santiago de Chile, Chile

It has been a common theme among commentators the consequences of the shift in forms of climate change as “danger”. The main problem is to define “danger” before it comes to a natural disaster. Natural disasters have been faced in Chile and South American countries in the last ten years and much attention has been given to such a shift at lower levels of warming. Furthermore, the consequences of average global temperature increase are not linearly distributed across regions. A differentiation of the spatial manifestation of change is therefore of high relevance for regional planning, people and local communities. This might be described as the “minimum” danger, a danger that has been noted clearly by none experts. On the other hand the “Chaitén” Volcano in 2008 and the Chilean Earthquake in 2010 show the degree of destruction of natural disasters. This might be described as a “strong” danger, a current one. In between is possible to find a danger that has been described but still is not defined by humans, it is subtle danger. Climate change is a “silence disaster” because it affects slowly without capability to be aware of the danger and the consequences of average global temperature increase increase slowly. It is difficult to say when this danger is going to be or when the disaster is going to be. It is subtle danger: Climate change is a “silence” because it affects slowly and people cannot really take it into account. The “Chaitén” volcano is a “sensibility disaster” because it affects slowly without capability to be aware of the danger and the consequences of average global temperature increase increase slowly. It is difficult to say when this danger is going to be or when the disaster is going to be. It is subtle danger: Climate change is a “silence” because it affects slowly and people cannot really take it into account.
in order to develop suitable coping strategies and adaptation options, as well as to inform decisions about the appropriate long-term global temperature goal.

P-2203-04

Detection of bifurcations in noisy coupled systems from multiple time series

M. Williamson (1); T. Lenton (1)
(1) University of Exeter, Exeter, United Kingdom

We generalize a method of detecting an approaching bifurcation in a time series of a noisy system from the special case of one dynamical variable to multiple dynamical variables. The system is described as a stochastic differential equation consisting of an autonomous deterministic part with one dynamical variable and an additive white noise term, small perturbations away from the system’s fixed point will decay slower the closer the system is to a bifurcation. This phenomenon is known as critical slowing down and all such systems exhibit this decay-type behaviour. However, when the deterministic part has multiple coupled dynamical variables, the possible dynamics can be much richer, exhibiting oscillatory and chaotic behaviour. In our generalization to the multi-variable case, we find additional indicators to decay rate, such as frequency of oscillation. In the case of approaching a homoclinic bifurcation, there is no change in decay rate but there is a decrease in frequency of oscillation. The expanded method therefore adds extra tools to help detect and classify approaching bifurcations given multiple time series, where the underlying dynamics are not fully known. Our generalisation also allows bifurcation detection to be applied spatially if one treats each spatial location as a new dynamical variable. One may then determine the unstable spatial mode(s). This is also something that has not been possible with the single variable method and is applicable to any set of time series regardless of its origin, but may be particularly useful when anticipating abrupt changes in the multi-dimensional climate system.

O-2204-01

Transformative solutions to high-end climate change

D. Tabara (1); J. Jaeger (2); P. Harrison (3); I. Holman (4)
(1) Independent consultant – UAB, ICTA, Barcelona, Spain; (2) Independent Consultant, Vijayagiri; (3) Environmental Change Institute, University of Oxford, Oxford, United Kingdom; (4) Cranfield University, Cranfield, United Kingdom

Current trends in greenhouse gas emissions show that limiting global warming to the international target of 2°C is likely to be difficult. Despite the increasing plausibility of high-end scenarios, there are few studies that assess transformative strategies and solutions to address potential synergies and trade-offs between adaptation, mitigation and sustainable development. The latest IPCC AR5 report defines transformation as ‘a change in the fundamental attributes of natural and human systems [...] that [...] reflects strengthened, altered, or aligned paradigms, goals, or values towards promoting adaptation that supports sustainable development, including poverty reduction’ (IPCC 2014: WGII, SPM p.5). However, the notion and implications of transformation in climate science and policy are poorly understood. On the one hand, transformation is an autonomous dimension which does not depend on, or is not necessarily conditioned by, either mitigation or adaptation strategies. But on the other hand, transformative adaptation and transformative mitigation policies can contribute to the development of decisive systems’ innovations to cope with high-end scenarios, while at the same time fostering sustainable development. To achieve this goal, knowledge and modelling tools on how to develop and implement ‘global systems of interconnected solutions’ are urgently required. The new emerging Global Systems Science (GSS) is a promising approach which could support integrated climate governance by looking at new modes of science appraisal, global governance arrangements and engagement with stakeholders. In particular, innovative climate strategies and solutions could take advantage of, and support, the transfer of global transformative forces already evident outside of the strictly climate domain. These include: 1. Increasing interest in the creation of a global citizenship, e.g., to redistribute global climate rights and responsibilities; 2. The development of win-win solutions to generate a green low-carbon economy, to replace the brown economy; 3. Opening Human Information and Knowledge Systems (HIKS) and connecting with Social-Ecological Change, to connect knowledge networks and agents globally to deal with specific sustainability needs and problems; and 4. The generation of distributed and conducive conditions for global cooperation and institutional capacity building, to ensure the equitable implementation of transformative strategies and policies in the long-term. This presentation will introduce this cluster of interconnected systems of global solutions, referred to as the ‘Global Transformation Propeller’, and suggest a framework to promote and implement transformative responses in the face of high-end scenarios. Our goal is to stimulate an open debate to explore the implications for climate science and policy of existing or potential transformative forces and how they can be connected to innovative solutions which are able to cope with HES while supporting sustainable development.

O-2204-02

Avoiding the impacts of climate change: Results from the BRACE study

B. O’Neill (1)
(1) National Center for Atmospheric Research (NCAR), Boulder, CO, United States of America

Understanding the potential consequences of climate change is vital for ecosystems and society is necessary for an informed response to the climate issue. A particularly important task is improving our understanding of how impacts differ across alternative levels of future climate change. Such understanding can help inform the balancing of the costs of climate change mitigation and adaptation with the benefits of reduced impacts. This talk will present results from a project led by the National Center for Atmospheric Research (NCAR) on the Benefits of Reduced Anthropogenic Climate changE (BRACE), which assesses the differences in impacts between two specific climate futures: those associated with Representative Concentration Pathways (RCPs) 4.5 and 8.5. The latter would lead to a likely global average temperature change of 3.2–5.4 C relative to pre-industrial temperatures by the end of the century, the former to a likely range of 1.7–3.2C degrees of warming. This project is quantifying avoided impacts in terms of extreme events, health, agriculture, tropical cyclones, and sea level rise. Methodologically, it combines climate modeling, statistical analysis, and impact assessment to examine physical, ecological, and societal impacts, and draws heavily on the use of large initial condition ensembles of climate model simulations in order to better account for internal variability and extreme events and to develop new approaches to pattern scaling techniques. Results show that the benefits of reduced climate change vary substantially across sectors, and depend importantly on assumptions about future societal conditions.

O-2204-03

Understanding and Addressing Infinite and Existential Climate Risks

J. Rockström (1)
(1) Stockholm Resilience Center, Stockholm university, Stockholm, Sweden
Scientific evidence indicates humanity has entered a new geological epoch, the Anthropocene, where the world enterprise constitutes the largest driver of change at the planetary scale. Furthermore, we increasingly find evidence that the social and environmental response to rising human pressures on the planet is such that the globalized world of the 21st century is associated with rising social-ecological turbulence. This raises the need to better understand risks of facing infinite or existential risks, which together with an increase in the amount of dead and decomposing wood, potentially turning the forest into a sinks for atmospheric CO2, and a significant proportion of the global population or the entire world community. In this presentation a methodology is made to investigate the risks including global climate change, forest mortality. Such observations provide important insights for model development at the physiological level. Combining measurements and new modelling approaches. Altogether, it is clear that new data are needed and it is essential that these processes will be investigated in a number of whole-ecosystem elevated CO2 experiment such as the AMAZON_FACE experiment which is also set up in the Amazon basin. These should be combined with other focused research projects further addressing drought and temperature dependence.

O-2204-05

Implications of growing CO2 emissions for staying below the 2°C limit

P. Friedlingstein (1)

(1) University of Exeter, Exeter, United Kingdom

Efforts to limit climate change below a given temperature level require that global emissions of CO2 cumulated over time remain below a limited quota. This quota varies depending on the temperature level, the desired probability of staying below this level and the contributions of other gases. Furthermore, global emissions of CO2 from fossil fuel combustion and cement production have continued to grow by 2.5% per year on average over the past decade. Two thirds of the CO2 emission quota associated with a 2°C temperature limit has already been used, and the total quota will likely be exhausted in a further 30 years at the 2014 emissions rates. I present recent analysis showing that CO2 emissions track the high end of the latest generation of emissions scenarios, due to lower than anticipated carbon intensity improvements of emerging economies and higher global gross domestic product growth. In the absence of more stringent mitigation, these trends are set to continue and further reduce the remaining quota until the onset of a potential new climate agreement in 2020. Breaking current emission trends in the short term is key to retaining credible climate targets within a rapidly diminishing emission quota.

P-2204-01

Climate change and very dangerous heat waves: Projecting frequency of high-mortality heat waves in 82 US communities in 2061—2080 under different climate, population, and adaptation scenarios

B. Anderson (1); K. Oleson, (2); B. Jones, (3); R. Peng, (4)

(1) Colorado State University, Environmental and Radiological Health Sciences, Fort Collins, CO, United States of America; (2) National Center for Atmospheric Research, Boulder, CO, United States of America; (3) CUNY Institute for Demographic Research, New York, NY, United States of America; (4) Johns Hopkins Bloomberg School of Public Health, Biostatistics, Baltimore, MD, United States of America

Certain rare heat waves, like the 2003 heat wave in France, can have devastating effects on a community’s public health and well-being. This paper seeks to predict which heat waves are likely to be such “very dangerous” heat waves, based on characteristics of the heat wave (e.g., intensity, length) and of the community in which it occurred (e.g., population density). Using recent (1987—2005) data from 82 large US urban communities. We built twenty potential classification models and used Monte Carlo cross-validation to evaluate these models, identifying the models capable of capturing the occurrence of very dangerous heat waves. Using these three models, we predicted the frequency of very dangerous heat waves in these 82 communities in 2061—2080 under two scenarios of climate change: RCP 6.0 (a stabilization scenario) and RCP 8.5 (a business-as-usual scenario). The occurrence of very dangerous heat waves was most strongly influenced by the pace at which communities may even grow through ‘CO2 fertilisation’, but this fertilisation effect is limited by the availability of nutrients such as nitrogen and phosphorus. At the same time, theory and some data sets predict that water use efficiency will increase, which may increase forest resistance but also reduce water cycling, potentially causing a climate warming feedback. The magnitude of these limiting effects is still uncertain due to poor understanding of soil nutrient dynamics and this must be improved by rigorously combining measurements and new modelling approaches.
are able to adapt to their changing climates. We found this signal also depended somewhat on climate change scenarios, while it was practically unchanged across different population scenarios, although these scenarios did influence projected person-days of exposure to very high temperatures in these wave. Our findings suggest that it is useful to consider adaptation scenarios when projecting health impacts of heat under climate change scenarios. Further, our findings suggest that community-level adaptation measures are likely to be a critical protection against future very dangerous heat waves.

P-2204-02

Early Entrants of Rainfall Index Insurance: Insights from Rural Households in Central West Nigeria

D. Awolola (1) ; A. Mbaye (2) ; J. Von Vraun (3) ; W. Fonta (4) ; S. Sanfo (4)

(1) Centre for Research and Development, Bonn, Germany; (2) Centre for Research and Development, West African science service centre on climate change and adapted land use (wascal), Bonn, Germany; (3) ZEF, Research, Bonn, Germany; (4) West African Science Service Center on Climate Change and Adapted Land Use (NASAACL), Competence center, Ouagadougou, Burkina Faso

Farmers have traditionally adapted to weather-induced production risks over time. The failures of subsidized crop insurance schemes and rising trends of climate extremes have increased their vulnerability to higher risks. With individual and group decision-making, some risk aversion from shocks would still lead to economic losses. Rainfall index insurance can transfer farmers’ risks and increase supports for agricultural lending. This study used cross-sectional data to analyze potential demand for rainfall index insurance as financial adaptation to extreme local climate in central west Nigeria. The study shows that monthly distribution of rainfall uncertainties thereby constraining optimal planning within the available production period. Farmers’ vulnerability to rainfall delay, early cessation, and occasional long dry spell has consequences on resource use productivity. There is demand for rainfall index insurance as nearly 65% demonstrated willingness to secure their ‘residual’ risk. Mean (n=352.91) and median WTP are 37.6% higher than their fellows who do not on average and ceteris paribus. For farmers who have access to seasonal forecast measures are likely to be a critical protection against future very dangerous heat waves.

P-2204-03

Managing Catastrophic Climate Risks under Model Uncertainty Aversion

L. Berger (1) ; J. Emmerling (2) ; M. Tavoni (3)

(1) Fondazione Eni Enrico Mattei (FEEM), Milan, Italy; (2) FEEM, Milano, Italy; (3) Fondazione Eni Enrico Mattei, Climate change and sustainable development programme, Milan, Italy

We propose a robust risk management approach to deal with the problem of catastrophic climate change which incorporates both risk and model uncertainty. Using a two-period model of optimal abatement, we show how model uncertainty and risk aversion interact. We disentangle the impact of preferences towards different types of uncertainty from the structure of model uncertainty on the optimal level of abatement, by means of a simple measure of model uncertainty. With data from expert elicitation about climate change catastrophes, we show the relative importance of these two effects and calibrate an integrated assessment model of climate change. The results indicate that the structure of model uncertainty, and specifically the convergence of agreement across models are the key driver of abatement, and that model uncertaintyaversion warrants a higher level of climate change mitigation.

P-2204-04

Treatment of uncertainties in the IPCC’s Fifth Assessment Report: Lessons learned for informing management of climate-related risks

M. Mastrandrea (1) ; K. Mach (1) ; V. Barros, (2) ; C. Field (3)

(1) Carnegie Institution for Science / IPCC WGII; (2) Stanford, CA, United States of America; (3) Universidad de Buenos Aires / IPCC WGII, Buenos Aires, Argentina; (3) Carnegie Institution for Science / IPCC WGII, Stanford, CA, United States of America

This presentation will discuss lessons learned through implementation of a common approach for characterizing the degree of certainty in findings of the assessment process in the Intergovernmental Panel on Climate Change’s Fifth Assessment Report (IPCC AR5), with a focus on informing climate risk management in future assessments. Managing climate-related risks involves decision making in a changing world, with continuing uncertainty about how climatic and non-climatic factors will evolve and interact over time. Risks result from the interaction of climate-related hazards with the exposure and vulnerability of society and the environment across plausible alternative development pathways. In the IPCC AR5, assessment of risks relied on diverse forms of evidence, including empirical observations, experimental results, process-based understanding, statistical approaches, and simulation and descriptive models. Expert judgment is critical in integrating such diverse evidence into evaluations of risks and in determining the extent to which risks can be quantified. The common approach used in the IPCC AR5 emphasizes assessment of the consequences and relative likelihoods of each of the most likely range of future outcomes, including low-probability outcomes with large consequences, to inform risk management. It also emphasizes providing clear traceable accounts of the confidence in and support for assessment findings. Describing an author team’s evaluation of the types, sources, and consistency of evidence and the degree of agreement underlying each finding. Clear traceable accounts ensure users of the assessment can understand the evaluation and integration of evidence supporting assessment findings. Further use of structured methods for organizing and quantifying expert judgment could aid future assessment efforts within and beyond the IPCC. For finding clear traceable and quantifying climate risks based on a diverse evidence base mixing quantitative and qualitative information.
**Sensitivity of Natural Micro-Regions of North-East Hungary to Landscape Degradation**

J. Mikai (1); A. Kertesz (2)
(1) Eszterhazy Karoly University College, Environmental Sciences and Landscape Ecology, Eger, Hungary; (2) Research Centre for Astronomy and Earth Sciences Hungarian Academy of Sciences, Budapest, Hungary

The objective of our research is to survey degradation processes acting in each micro-region, as well as to investigate the sensitivity of the micro-regions to degradation. A survey of land degradation processes has been carried out at medium scale (1:50,000) to identify the affected areas in the region. The methods include field work, analysis of topographical maps and remote sensing materials, statistical analyses, GIS methods and preparation of photo documents. The sensitivity of landscapes will change in the future because of global climate change. As a consequence of this, the extent and the intensity of degradation processes may change, too. Regional climate scenarios, based on GCM, RCM and empirical downscaling are all included and synthesized for the specified hilly region of ca. 20,000 sq. km. The scenario, scoping at 50 years ahead with possible linear interpolation and extrapolation in time, include changes of seasonal means and expected changes in some extreme event, as well. The following land degradation processes are included in the database of the present and expected future states: (i.) Land (soil) degradation involving soil erosion, sheet erosion, gully erosion, wind erosion, mass movements, salinization, degradation due to soil structure changes, soil sealing. (ii.) Removal of vegetation due to deforestation and to the expansion of urban, industrial areas, transport tracks, etc. (iii.) Desertification. (iv.) Degradation of the scenic value of the landscape. (v.) Degradation due to land use change (other changes than those under (ii.)). (vi.) Two types of abandoned mines (high, low intensity, etc.). (vii.) Desertification. The sensitivity of the natural micro-regions to degradation are determined by applying sensitivity indices. Different factors are the driving forces of the various degradation processes and so different indices are created for each process with specific weighting of the identified factors, mostly based on empirical regression analyses. The concept of the index was based on the MEDALUS index (Kosmas et al. 1999). The factors included in the investigation are: (a) Soil properties (soil structure, soil water budget, organic matter content, salinity, soil parent material). (b) Climate properties (drought, floods, precipitation, rainfall intensity). (c) Vegetation properties (forest fire risk, sensitivity of vegetation to drought, vegetation cover %). (d) Surface and subsurface water properties (ground water depth, flood risk, nutrient risk). (e) Anthropogenic load (water use, waste disposal, population change, land use intensity). Finally the sensitivity index values are shown in maps. The sensitivity of natural micro-regions of North-East Hungary is also investigated under the circumstances of the expected climate change scenario, applied to characterise landscape sensitivity in the future. The map of the existing land degradation processes, sensitivity maps of the present and simulated future climatic conditions are analysed by GIS methods. The map series and the evaluation provide important information about the state and sensitivity of the natural micro-regions and this information is useful for decision making. The current research has been supported by the OTKA-K108755 national project.

**Climate Change Induced Excessive Heat Exposure Undermines Global Health Equity and Economic Development**

M. Otto (1); B. Lemke, (2); T. Kjellstrom, (3); C. Freyberg, (3); D. Briggs, (3); O. Hyatt, (3)
(1) Nelson Marlborough Institute of Technology, Digital Technology, Nelson, New Zealand; (2) Nelson Marlborough Institute of Technology, Nelson, New Zealand; (3) Ruby Coast Research Centre, Mapua, New Zealand

The physiological limits of the human body in coping with high heat exposure and heat stress are relatively well established since several decades. However, the implications of climate change trends of extreme heat have only recently been analyzed. The health effects include heat exhaustion (which reduces work capacity and labor productivity), clinical symptoms, and the increased incidence of certain chronic diseases and acute fatalities. Physical work adds in a major way to the heat stress because of the internal heat production from muscle work.

Our analysis compares the population based estimates of health impacts of heat for selected climate models applied to RCP8.5 (the current emission track) and RCP6.0 (what might be achieved with more stringent climate mitigation policies). The global mean temperature increase this century for RCP8.5 using various models generally ranges between 3 and 5°C, while the RCP6.0 increase generally ranges between 1.5 and 2.5°C.

Whichever health outcome is analysed poor people are always at highest risk as they are likely to be in heavy physical work and they cannot afford air conditioning to the same extent as higher income people. Poor people in low and middle income tropical countries are at particular risk as most of these countries already experience several months of extreme heat each year. The heat exposure levels expressed as ‘millions of person hours of exposure above agreed heat risk limits’ are particularly high in these countries from a global health perspective. For example, working people in SE Asia, where the prevailing ambient heat levels, will lose as much as 30% of the daylight work hours in the hottest month and the annual loss will be 8% as these hours are too hot for moderate level continuous work. In SE USA the equivalent losses are 5% in the hottest month and 2% annually. (more examples will be added in the final presentation)

**The relative role of anthropogenic climate change on risk of heat mortality in the European heatwave of 2003**

D. Mitchell (1); C. Huntingford (2); C. Heaviside, (3); S. Vardoulakis, (3); F. Otto (1); M. Allen (4); P. Frumhoff (5)
(1) University of Oxford, Oxford, United Kingdom; (2) CEH, Wallingford, United Kingdom; (3) Public Health England, Oxford, United Kingdom; (4) University of Oxford, School of Geography and Environment and Dept of Physics, Oxford, UK; (5) Union of Concerned Scientists, Cambridge, MA, United States of America

The 2003 European heat wave was one of the most extreme meteorological events in terms of loss of life in Europe in recent times. Estimates of excess heat-related deaths for this event could be as high as 70,000, with France being particularly affected.

The chaotic nature of the climate system is such that extreme meteorological events of this magnitude will to some extent always occur “by chance”. However external factors may increase or decrease the frequency of occurrence. Such factors include climate change related to anthropogenic influences, such as greenhouse gas emissions and land use change, but also natural influences such as changes in solar output, and large volcanic eruptions.

Here we use a unique modelling capability to perform massive ensembles of climate model simulations (“climateprediction-dot-net: CPDNN”), which enables assessment of any of the major climate system meteorological extremes of interest. We compare scenarios representing the year 2003 (i) as it actually was (i.e. where natural and anthropogenic conditions are used to drive the climate model: ‘control’), and (ii) as it could have been, if humans had not altered atmospheric gas composition (i.e. with only natural conditions; “scenario 2”).

This study considers each aspect of the 2003 heat wave, from the inherent warmer atmosphere due to raised greenhouse gas concentrations, to any additional confounding and related changes in probability of altered large-scale atmospheric circulation patterns. We use baseline health and demographic data to estimate associated mortality impacts for the local populations. An additional feature of CPDNN is that each global simulation contains a high-resolution “nested” regional climate model centred on Europe. This high-resolution modelling capability allows us to perform a new level of the analysis at the city level. For Scenario’s 1 and 2, we therefore show how heat-related mortality changed over Paris during 2003.
The increasing heat impacts on clinical health and labor productivity to improvements in health equity at global, national and local level, as the people most vulnerable to heat stress are those with poor living and working environments and many of them already have health problems. The labor potential loss also undermines local economic development and slow down any progress in poverty reduction programs.

P-2204-08

Climate analysis at local scale in the context of climate change

H. Quenol (1)
(1) CNRS – UMR6554 LETG, Université Rennes 2, Rennes, France

Issues related to climate change increasingly concern the functioning of local scale geo-systems. A global change will necessarily affect local climates. In this context, the potential impacts of climate change lead to numerous interrogations concerning adaptation. Despite numerous studies on the impact of projected global warming on different regions, global atmospheric models (GCM) are not adapted to local scales and, as a result, impacts at local scales are still approximate. Although real progress in regional and local scale modelling were made over the years, no operative model is in use to simulate climate at local scales (ten or so meters). It is therefore at a finer spatial scale, which considers land surface characteristics, it will be possible to assess the impact of climate change. This scientific approach aims to develop a methodology based on climatic observations in situ and on spatial modeling of climate, which permits to evaluate the spatial variability of atmospheric parameters at fine scales (mean values and climatic extremes). By completing the lack of data at local scales, this work allows to improve the understanding on climate changes that may appear at local scale and thus advance the assessment of the potential impacts. This methodology is developed and applied in agro climatology (viticulture) and in urban climatology.

In viticulture, the LIFE-ADVICLIM (LIFE13 ENV/FR/001512: ADapation of Viticulture to CLIMate change : High resolution observations of adaptation scenarios for viticulture) project aims at observing climate at local scales in different European vineyards, representing the climate diversity in European wine regions; simulating climate and climate change in order to produce a fine scale assessment of the climate change impacts, thereafter simulating scenarios of adaptation for viticulture. Climate models at fine scales will include (i) the output from numerical EURO-CORDEX models with a kilometer resolution (ii) the spatial modeling of climatic data from the measurement networks using multicriteria modeling at very high resolution (500 m), and (iii) the future climate simulations using meso-scale climatic model ran under different scenarios of climate change. (i) The coarse resolution output from numerical climate models require downscaling. We use the downscaling output of EURO-CORDEX. It will provide knowledge and understanding of climate variability at meso-scale in the different studied European wine regions. Climatic data from national weather station networks will be used to validate the outputs of modelled data. (ii) In order to construct fine-scale spatial temperature fields, the multicriteria modelling will be used. This approach takes environmental factors into account. Indeed, the role of topographic factors in the spatial variability of temperatures at fine scales, in addition to the influence of geographical position (latitude, longitude, altitude) at large scales, has already been demonstrated. This type of modeling will make use of the climatic data provided by the fine scale network. (iii) We use simulations of climate change scenarios (for Europe) carried out CORDEX program

For example, the results of the measurements and modeling adapted at terroir scales have permitted to highlight the spatial variability of climate at very small spaces. In terms of temperatures, the spatial differences generated by the local conditions (topography, etc.) are very often greater than the increase in temperatures simulated at global scale scenarios of IPCC for the next 50 years. Vine growers adapt their practices to this spatial variability of climate that partly determines the characteristics and uniqueness of their wine. In the context of the current scientific approach, a spatial analysis could be a method to adapt to the temporal changes in climate, especially in the short and medium term.

In urban climatology, the same scientific approach (measurement and modeling at fine scales) has been applied. The same methodology was applied in Rennes city. The results showed a strong spatial variability of the temperatures in relation to local characteristics of the city (e.g. heat island effect). The labor potential loss also undermines local economic development and slow down any progress in poverty reduction programs.

P-2204-09

The risk of drought in Ukraine under changing climate in the future medium term

I. Semenova (1)
(1) Odessa State Environmental University, Theoretical meteorology and meteorological forecasts, Odessa, Ukraine

The territory of Ukraine almost every year is exposed the drought of different intensity and duration. The country is belongs to main agricultural area of East Europe, therefore the drought in vegetation season can considerably worsen the productivity of grain crops. As studies shows, the seasonal (or agricultural) drought is the widespread in Ukraine with dominating in spring and summer time. In last two decades the full vegetation season droughts were observed in 1999, 2007, 2009 and 2012. Most important summer-droughts occurred during period of 2003, 2007 and 2012. In this years were fixed the large crop losses of winter wheat and spring barley - 10-43% from the trend.

Under the climate changing is become important the estimates of future drought risks, which is necessary for long-term economic planning. For assessment of the drought frequency in the future was used data of CMIP5 (Coupled Model Intercomparison Project, phase 5) for period 2020-2050.

Analysis of spatial and temporal distribution of drought was held using the index SPI. For its calculation has been used multimodel (32 models) monthly mean precipitation data for two boundary scenarios, which represents the RCP (Representative Concentration Pathways), experiment RCP2.6 and RCP8.5. Under the scenario RCP2.6 surface air temperature anomaly in Ukraine until 2050 will be +0.7, +2.1 degrees Celsius compared with a baseline period 1981–2010. According to the scenario RCP8.5 increasing of temperature can be up to +2.8, +3.1 degrees Celsius. Precipitation will be slightly increased in both scenarios.

SPI was examined for three timescales 12, 7 and 3 months, in order to cover droughts of different duration.

The SPI2 analysis for local points showed that at the RCP2.6 some significant dry periods will be observed in 2020’s and 2040’s, but at the RCP8.5 expected increasing the intensity and duration of drought episodes after 2035. The most severe drought is projected in 2042–2045.

The SPI7 analysis during vegetation season (April–October) showed that at the RCP2.6 total number of drought will be several larger than at the RCP8.5. The frequency of weak and moderate droughts at the RCP2.6 averaged to 12-14 cases per 31 years, according to the RCP8.5 is 10-12 cases. Severe and extreme droughts under both scenarios are expected in 1 to 4 years, but not everywhere.

Analysis of drought frequency in different seasons using SPI3 showed that during 2020-2050 expected a slight increasing the total number of drought and its redistribution within the warm season. The increasing of the number summer-autumn droughts (August–October) and reducing of summer droughts (June–August) are projected, especially in mild scenario RCP2.6. The frequency of drought could reach up one every 2–3 years across regions. Maximum number of droughts in all seasons predicted for the northeast and western regions of Ukraine, which in the present climate are not too arid. Contrariwise in the Steppe the total number of droughts almost not changes, but remains a high probability of severe and extreme drought.
Modelling the ice dynamics of Himalayan glaciers

S. Shannon (1) ; T. Payne (2) ; R. Betts (1) ; A. Wiltshire (3)
(1) University of Exeter, Geography, Exeter, United Kingdom; (2) University of Bristol, Bristol glaciology centre, Bristol, United Kingdom; (3) Met Office Hadley Centre, Exeter, United Kingdom

In the Himalayan–Karakoram glacier melt contributes to the rise of sea levels and Brahmaputra rivers affecting the livelihoods of more than 700 million people[1]. Future glacier melting is of particular concern for high-end climate change scenarios because of the potential increase in water availability. Projections suggest that runoff may increase until 2050, due to enhanced glacier melting combined with an increase in monsoon precipitation [2, 3]. The uncertainty in these estimates are associated with an over simplified treatment of glaciers and a poor representation of monsoon precipitation.

To assess the impact of glacier retreat on food and water security in the region, we are implementing a 1-D glacier flow model [4] into the Joint UK Land Environment Simulator (JULES) integrated impacts model. The purpose of the JULES impacts model is to allow for an integrated, internally consistent Joint UK model of impacts of climate change on glaciers, water resources and agriculture. The JULES impacts model is currently under development and includes a river routing scheme [5], an irrigation scheme and crop plant functions types[6].

In this presentation, we describe the initial stages of the model development. The glacier model requires two inputs: knowledge of the present day ice thickness and surface mass balance (SMB) as a function of elevation. Ice thickness is calculated using an inversion technique based on the principles of ice flow dynamics [7, 8]. This technique uses satellite observations of glacier outlines [9] combined with a digital elevation model. A time series of SMB generated by JULES is used to drive the glacier flow model offline. We show preliminary results of glacier flow simulations in the Himalayan–Karakoram.


Heat stress in a warming world: implications for human health and productivity under different climate scenarios

J. Syktus (1) ; C. Micali (2)
(1) University of Queensland, School of Geography, Planning and Environmental Management, Brisbane, France; (2) University of Queensland, School of geography, planning and environmental management, Brisbane, Australia

Projected changes in temperature and humidity over the course of the 21st Century will contribute to increased heat stress in many tropical and sub-tropical regions. Heat stress, arising from a combination of high temperature and humidity impacts on human health and wellbeing by causing illness and death, with the young and old the most vulnerable. Increased heat stress impacts workforce productivity, especially those engage in manual labour in open environments such as construction, mining and agriculture. These impacts will be of increasing concern during coming decades due to projected significant increases in the rate of warming and rapidly growing populations tropical and sub-tropical regions.

We evaluated the impact of different emission scenarios on the heat stress conditions for the 21st Century in tropical and sub-tropical regions using wet-bulb globe temperature (WBGT) heat stress index. Projected changes in WBGT were used to assess the future impacts of heat stress by combining time-varying changes in heat stress and human population numbers. We found that people living in cities in coastal tropical regions and cities are highly vulnerable to changes in the number of heat stressdays with these increasing in some instances from close to zero to two hundred days per year by 2100. West Africa, the Caribbean and the Indian sub-continent will be particularly hard hit. We showed the benefits of mitigation by comparing the distribution of heat stress under RCP8.5 and RCP2.6.

Estimated impacts of emissions reductions on wheat and maize crops

C. Tebaldi (1) ; D. Lobell (2)
(1) NCAR, CGD, Boulder, CO, United States of America; (2) Stanford University, Department of environmental earth system science, Stanford, United States of America

An ability to quantify the impacts associated with different emissions scenarios across a broad range of economic and environmental outcomes would be helpful for guiding policy on energy and greenhouse gas emissions. One outcome of particular interest, especially for food insecure populations, is effects on agricultural productivity. In this study we use empirical models of the relation between climate and CO2 concentration on the one hand, and changes in crop yields on the other, to characterize the differential impacts of one future scenario for two major crops of two level of forcings: those associated with RCP4.5 and those associated with RCP8.5. This study is part of a larger project on the Benefits of Reducing Anthropogenic Climate Change (BRAISE). We consider differential effects on maize and wheat yields at the global scale from expected changes in mean temperature and precipitation under the two scenarios. We also characterize differential levels of exposure to damaging heat extremes. Several time horizons are considered, characterizing expected impacts over the short, middle and long terms over the 21st century.

Evaluating the risk of hydrological drought to the irrigation sector under future climate scenarios: the case study of Puglia Region (Italy)

S. Torresan (1) ; P. Ronco (2) ; F. Zennaro (2) ; A. Crito (2) ; M. Santini (3) ; A. Trabucco (4) ; A. Marcomini (2)
(1) Centro Euro–Mediterraneo sui Cambiamenti Climatici, Risk Assessment and Adaptation Strategies Division, Venice, Italy; (2) Ca’ Foscari University, Dept. of environmental sciences, informatics and statistics, Venice, Italy; (3) Centro Euro–Mediterraneo sui Cambiamenti Climatici, Impacts on agriculture, forests and ecosystem services, Viterbo, Italy; (4) Centro Euro–Mediterraneo sui Cambiamenti Climatici, Informatics and statistical analysis, Venice, Italy.

P-2204-10
P-2204-11
P-2204-12
P-2204-13
In several regions, but especially in semi-arid areas, the raising drought events caused by climate change are expected to dramatically reduce the current stocks of freshwater resources, also used for irrigation purposes. The achievement of a sustainable equilibrium between the actual water demand and water resource supply is essentially related to the planning and implementation of evidence-based adaptation strategies and actions.

In this sense, the improvement of existing irrigation systems and the design and development of new water infrastructures are a crucial aspect to manage future warming scenarios. The irrigation sector is expected to be at high risk of hydrological droughts due to climate change on the irrigated agricultural compartment that cover a large portion of Puglia, a semi-arid region with the largest agricultural production in Southern Italy.

Based on the theoretical framework of Regional Risk Assessment (RRA) approach, the methodology is applied within a scenario-based hazard framework, where future climate projections provided by COSMO-CLM are considered under the radiative forcing RCP4.5 and RCP8.5 in two different timeframes (2021-2050 and 2041-2070). The run-off from the largest rivers of the region has been modelled by means of the Arc-SWAT model. The risk methodology follows four subsequent levels of analysis (i.e., hazards, exposure, vulnerability and risk assessments). Each step has been characterized by specific algorithms for their spatial and numerical quantification. Hazard scores have been modelled as the degree of fulfilment of Reclamation Consortia irrigation demand and then converted to the volume of available water supplied by the different reservoirs. Exposure assessment consists on the spatial characterization of the most vulnerable areas in Puglia, according to the specific crops that are cultivated. Vulnerability scores have been designed as function of three different factors that accounts for the agronomic and structural pattern of irrigation schemes (3), the variation in daily demand and then converted to the volume of available water supplies other than the reservoirs’ alone). Finally, relative risk maps (GIS based) and related statistics have been produced allowing the identification of hot spots and areas at risk as well as the spatial characterization of the risk pattern. The assessment allowed: (i) the identification of Reclamation Consortia at higher risk of not fulfilling their irrigation demand in future perspectives (e.g., Capitanatza Reclamation Consortia in RCP8.5 2041–2070 scenario); (ii) to identify the most affected crops (e.g. fruit trees and vineyards); and finally, to characterize the vulnerability pattern of the water systems and networks. According to these results, tailored and knowledge-based adaptation strategies and related actions can be developed, to reduce the risk pattern at both agronomic level (preferably at structural level (differentiating the water stocks and supplies and reducing losses and inefficiencies).

The latest scientific evidence suggest that the increase in global mean temperature is likely to exceed the 2°C and target the 4°C to 6°C by the end of the 21st century. Furthermore, most of Europe is expected to warm more than the average global warming rate of 1°C to 2°C by the end of the century. The potential environmental, economic and social impacts of such high-end warming scenarios has drawn the attention of the scientific community, which has a crucial role in advising future policy making. In the framework of High-End Climate Impacts and xExtemes (HELIx) FP7 project, five biophysical impact studies have been designed to investigate the effect of high global warming levels over Europe. Impact models are focused on water management (JULES), floods, water resources and droughts (LiSflood), coastal hazard (Hazcoast), Energy (Poles) and crop (Orchidee).

Models are tested and validated against large scale past extreme events such as major droughts and flood events that have occurred in the recent past. Calibrated models are now used to carry out new regional climate projections to evaluate changes in key indicators within the considered sectors over Europe. Output simulations are then used to examine possible implications of uncertainties in global patterns of climate change at 4°C for impacts at regional scales. Results are assessed and compared to the available CMIP5 based projections included in the Inter-Sectoral Impact Model Inter-comparison Project (ISI-MIP) over Europe. Here, first results of the coordinated modeling effort are presented for the examined sectors.

T. Welle, (1) ; J. Birkmann (1) ; M. Gashgaren, (2) ; T. L. Alfieri (1) ; I. Tsanis (1) ; L. Alfieri (2) ; A. Koutroulis (1) ; M. Grillakis (1) ; L. Fedyn (2) ; M. Voudoukas (2) ; E. Voukouvalas (2) ; M. Rozsai (3) ; A. Kitous, (3) ; P. Ciais (4) ; X. Wang (4) ; K. Wyser (5)

(1) Technical University of Crete, School of environmental engineering, Rethymno, Greece. (2) DG JRC, Institute for environment and sustainability, Ispra, Italy.
(3) European Commission – DG JRC, Institute for prospective technological studies, Seville, Spain. (4) LSCE, CEA, CNRS and UMR 7532, Gif-sur-Yvette, France. (5) Swedish Meteorological and Hydrological Institute (SMHI), Svalbyby, centre, Norrkoping, Sweden

How does urbanization modify climate related risk in urban areas on global scale?

T. Welle, (1) ; J. Birkmann (1) ; M. Gashgaren, (2) ; T. L. Alfieri (1) ; I. Tsanis (1) ; L. Alfieri (2) ; A. Koutroulis (1) ; M. Grillakis (1) ; L. Fedyn (2) ; M. Voudoukas (2) ; E. Voukouvalas (2) ; M. Rozsai (3) ; A. Kitous, (3) ; P. Ciais (4) ; X. Wang (4) ; K. Wyser (5)

(1) Technical University of Crete, School of environmental engineering, Rethymno, Greece. (2) DG JRC, Institute for environment and sustainability, Ispra, Italy.
(3) European Commission – DG JRC, Institute for prospective technological studies, Seville, Spain. (4) LSCE, CEA, CNRS and UMR 7532, Gif-sur-Yvette, France. (5) Swedish Meteorological and Hydrological Institute (SMHI), Svalbyby, centre, Norrkoping, Sweden

Climate change and urbanization are two global megatrends that will influence risk to climate change as well as adaptation opportunities and constraints. Sea-level rise, as well as the transition from managed to self-regulating estuaries, will be modified by climate change and most likely impact particularly urban areas in coastal zones in the future. The IPCC fifth assessment report (AR5) underscored that more than half of the world’s population lives in urban areas (1.3-2.4 billion). Of this, 90% of the urban population will live in urban areas whereas 6% will live in rural areas. Against this background and also considering the discussion of sustainable development goals (SDGs) and the post-2015 framework for disaster risk reduction there is an increasing need to assess whether future urbanization will increase risks related to climate change or in contrast whether urbanization might provide a vehicle for risk reduction regarding climate related hazards.

Consequently, the question of how urbanization influences core determinants of risk, particularly vulnerability – either in a positive or negative way – has not yet been clearly answered. The paper examines the nexus between urbanization, urban growth and vulnerability, based on vulnerability assessments using global remotely sensed land use data for 140 countries. In this regard, vulnerability is defined as a combination of susceptibility, coping and adaptive capacities. The findings show among other issues that a high level of urbanization (>75%) and a low urban growth rate (<1%) at national scale in general implies a rather low level of urban vulnerability. In contrast, countries that are characterized by a low level of urbanization (~40%) but very high urban growth rates (more than 3%) often tend to be countries with a high level of vulnerability in urban areas. The paper presents in detail selected findings and methods to assess the vulnerability and risk patterns in various countries, also based on the WorldRiskIndex concept. The triangulation of different data, such as remote sensing data, hazard data and various available socio-economic indicators, is presented as well as constraints and limitations of it. Exposure, vulnerability and risk maps for urban areas with a national scale resolution will underscore that risk and adaptation strategies need to be tailored and flexible in order to improve regional management approaches.

Overall, the presentation provides new insights in risk and vulnerability data and respective assessment methods for urban areas. Based on these findings specific recommendations for policy making and new risk monitoring tools will be derived that also consider prioritizing urban areas defined in the fields of climate change adaptation (programme on loss and damage) and disaster risk reduction.
Current structural changes in global economic network amplify heat stress-induced production losses

L. Wenz (1) ; A. Levermann (2)
(1) Potsdam-Institute for Climate Impact Research, Sustainable Solutions, Potsdam, Germany; (2) Potsdam Institute for Climate Impact Research, Research Domain Sustainable Solutions, Potsdam, France

Above a certain temperature threshold labor productivity has been shown to decline in exposed sectors such as construction and agriculture. Under future warming daily temperature will increase and thereby affect economic output. Here, we assess primary, secondary and higher-order losses from reduced labor productivity under past and present economic conditions under unabated climate change. Unsurprisingly, we find that relative damages increase linearly with rising temperatures.

Crucial for future adaptation strategies we observe that the structure of the global economic network plays an important role in absolute damage level. A new network approach is found to represent the network’s vulnerability to propagation of unanticipated damages well. This Global Adaptive Pressure (GAP) is shown to increase with the network’s sensitivity to heat stress-induced damages.

From data of the global economic network we learn that the Global Adaptive Pressure has been steadily increasing since 1998 (with an exception for the post-financial crisis years 2009 and 2010). As GAP is a relative measure, this increase does not merely represent economic growth but a structural change.

Our finding suggests that the current evolution of the global economic network may amplify heat stress-induced damages and thus necessitate structural adaptation that requires more foresight than currently prevalent.

Mapping of risk interconnection under climate change

T. Yokohata (1); K. Nishina (1); T. Kiyoshi (1); S. Emori (1); K. Tanaka (1); M. Kiguchi (2); Y. Iseri (3); Y. Honda (4); M. Okada (4); Y. Itohara (5); A. Tameneers (6); J. Shigemitsu (7); M. Yoshimori (7); T. Sueyoshi (8); K. Iwase (9); N. Hanasaki (1); A. Ito (1); G. Sakurai (5); I. Toshichika (5); T. Oki (2)

2205 - Multi-sectoral analysis of risks to climate change (hot spots) at 2 °C warming

The IMPACT2C project adopts a clear and logical structure within climate- and impact-modelling, vulnerabilities, risks and economic cost assessments. Detailed climate change scenarios are provided and tailored to the needs of various sectors. Here the information from the new EURO-CORDEX simulations will be presented. Furthermore, selected innovative methods (e.g. ensemble model selection which represent the entire ensemble’s spread) and tools (e.g. web atlas) will be shown.

The IMPACT2C project adopts a clear and logical structure within climate- and impact-modelling, vulnerabilities, risks and economic cost assessments. Detailed climate change scenarios are provided and tailored to the needs of various sectors. Here the information from the new EURO-CORDEX simulations will be presented. Furthermore, selected innovative methods (e.g. ensemble model selection which represent the entire ensemble’s spread) and tools (e.g. web atlas) will be shown.
Projected changes in drought at 4°C and 2°C of global warming: Impact of mitigation on regional drought hotspots

J. Syktus (1); C. Mcalpine (1)
(1) University of Queensland, School of geography, planning and environmental management, Brisbane, Australia

We use the CMIP5 data from historical and RCP8.5 simulations to complete a multi-model assessment of changes in regional patterns of warming and precipitation changes at 40°C and 20°C of global warming. Inter-model and inter-scenario changes in magnitude and sign of annual and seasonal precipitation has been calculated to illustrate the patterns of change in hydrological cycle. In addition projected changes in precipitation have been used to derive a meteorological drought using the Standardized Precipitation Index (SPI).

Analysis of multi-model distribution of SPI during the 21st Century show progressive increase in frequency of wet events in high–to mid–latitudes and increased frequency of droughts over large parts of Australia, Africa, south–east Asia, southern Europe, the Middle East and Northern and Southern Americas. Using this data we identified a key hotspot with extreme drought (SPI<−2) and computed regional statistics of drought frequencies at 40°C and 20°C on order to illustrate the regional benefits of climate mitigation. In addition we have completed regional analysis of joint distribution of precipitation and temperature changes at 40°C and 20°C using standardized precipitation and temperature index. We will show results of analysis focusing on hemispheric contrast in SPI drought distribution during the 21st Century.

Impacts of a global 2 degrees C climate change upon European air quality

G. Lacressonnière (1); M. Engardt (2); M. Gauss (3); L. Watson (4); C. Andersson (5); M. Bekkman (6); A. Colette (7); G. Foret (1); B. Josses (4); V. Marecval (8); A. Nyiri (3); G. Siour (1); S. Sobolowski (8); R. Vautard (9)
(1) IPSL/LISA, Créteil, France; (2) Swedish Meteorological and Hydrological Institute, Norrköping, Sweden; (3) EMEP MSW, Norwegian Meteorological Institute, Bergen, Norway; (4) CNRM–GAME, Météo–France and CNRS, Toulouse, France; (5) SMHI, Norrköping, Sweden; (6) LISA, CNRS/INSU, Créteil, France; (7) INERIS, Verneuil–en–Halatte, France; (8) Unité de recherche, the Bergen Climate Centre for Climate Research, Bergen, Norway; (9) Laboratoire des Sciences du Climat et de l’Environnement, Saclay, France

Several policy statements, including the 2009 Copenhagen Accord, stated that global temperature rise should be held below 2 degrees C above pre–industrial levels in order to limit the impacts of climate change. In this context, the impacts of 2-degree increase in temperature have been analyzed in the European project IMPACT2C. The objective of the present study is to evaluate how these changes will have an impact on European air quality and will potentially affect human health using four offline atmospheric chemistry transport models. The first step was to perform air quality simulations for the current climate, using two sets of meteorological forcings for each model: reanalysis of past observation data and global climate model output. The differences between the simulations allow to evaluate how global climate models modify climate hindcast by boundary conditions inputs. Among others, we analyze whether the chemical composition of PM is affected by the use of climate models. We then investigate the contributions of the changes in meteorological parameters (precipitation, temperature, boundary layer height) on surface primary and secondary compounds of PM (Lacressonnière et al., under review). For the future scenarios, the time period that corresponds to a 2-degree C global warming, such as predicted from climate simulations using RCP2.6 scenario, has been used. This time period varies depending on which global climate model is used. We separately calculate the effects of climate change and emission reduction scenarios, and show that the fate of European air pollution is controlled by emission reductions. A 2-degree C global warming will not hinder beneficial effects of air quality legislation, albeit inducing small changes in ozone and particulate matter changes. We then evaluate the uncertainty associated to the air quality projection under regional climate change, with a focus on annual PM2.5 and SOMO35, two indicators commonly used for health assessments (Lacressonnière et al., under preparation). We assess the robustness/uncertainty of model predictions, by comparing the inter-model spread to the climate change signals. Our results highlight that the inter-model spread is mainly due to differences in regional climate projections, affecting several meteorological parameters, which are crucial for air quality. Beyond the model uncertainty, climate penalty or benefit have been much evident over different European areas. The use of four different models, and additional uncertainty evaluations, make our study one of the most comprehensive ones up to date to assess the impact of regional climate change on air quality and health.
P-2205-04

Studying the climate change impact at 2 degree warming on Water Resources for the island of Crete: A cross-sectoral approach

I. Tsanis (1) ; A. Kouthoulis (2) ; M. Grillakis (2)
(1) McMaster University, Civil Engineering, Hamilton, Ontario, Canada; (2) Technical University of Crete, School of environmental engineering, Chania, Greece

Ensemble pan-European projections under a 2°C global warming relative to preindustrial period reveal a more intense warming in south Eastern Europe by up to +3°C. Indigenous forest impacts of climate changes are disproportionate on certain regions. The Mediterranean area is projected as one of the most vulnerable areas to climatic and anthropogenic changes with decreasing rainfall trends and an increase in the water stress. The forest sector would experience a decline in the average stream flow. Many Mediterranean regions are currently experiencing high to severe water stress induced by human and climate drivers. Changes in average climate conditions will increase this stress notably because of a 30–50% decline in freshwater resources. For small island states, where accessibility to freshwater resources is limited the impact will be more pronounced. Here, we used a cross-sectoral framework to assess the impact of climatic and socioeconomic futures on the water resources of an Eastern Mediterranean island, Crete, the fifth largest Mediterranean island covers more than 5% of Greece with an area over 8,000 square km. Total water use is estimated to be about 420 million cubic meters (6.3% of total precipitation). The majority of the water use (over 80%) is used for irrigation while the rest is distributed to other uses such as domestic, tourist, and industrial uses. A set of representative regional climate models simulations from the ENSEMBLES and EURO-CORDEX initiative driven by different RCP2.6, RCP 4.5, A1B and RCP8.5 GCMs were used to form a comparable set of results and a useful basis for the assessment of uncertainties related to impacts of 2 degrees warming and above. A generalized framework of a cross-sectoral water resources analysis was developed in collaboration with the local water authority exploring and costing adaptation measures associated with a set of socioeconomic pathways (SSPs). Transient hydrological modeling was performed to describe the projected hydro-climatological regime and water availability for each warming level. The robust signal of less precipitation and higher temperatures that is projected by climate simulations results to a severe decrease of local water resources. Adaptation to water scarcity includes a group of measures ranging from soft measures to infrastructure investments for achieving safe and secure water futures.

P-2205-02

The 2°C global warming threshold and associated hydrological changes over France

G. Dayon (1); J. Boé (1); E. Martin (2)
(1) URA1875, Cerfacs/CNRS, TOULOUSE, France; (2) Méteo France, Cnrm-game, Toulouse, France

The Copenhagen Agreement states that the global temperature should increase less than 2°C to prevent dangerous changes on the climate system. The 2°C threshold offer to climate scientists an easy way to communicate and present their results close to policy decisions and meaningful for the public. However, it hides strong differences and uncertainties at a regional scale. This study focuses on impacts of the 2°C level and above on the continental hydrological cycle over France.

An ensemble of Global Climate Models (GCMs) simulations from the Coupled Model Intercomparison Phase 5 (CMIP5) is downscaled with a statistical method developed in a previous study (Dayon et al. 2015). Atmospheric variables obtained on a 8 km grid over France are used to drive the Isba-Modcou hydrological system developed at Météo France and Mines Paris–Tech. Isba is a land surface model that calculates the energy and surface water budgets. Modcou is a hydrogeological model that routes the surface runoff given by Isba and computes aquifers and river flow evolution.

Future impacts of climate change on the hydrological cycle of the main French rivers basins are evaluated as a function of global temperature warming. The respective importance of uncertainties from the internal climate variability and climate models is addressed thanks to large ensemble of simulations studied. Hydrological changes are also compared among the Radiative Concentration Pathway (RCP, mainly RCP4.5 and RCP8.5) to ensure the independence of results to emission scenarios.

Finally, based on a large ensemble of simulations on the historical period (28) and long-term river flow observations, future hydrological changes are put into perspective with past hydrological variability. Those elements might allow to reach a conclusion on the meaning of the 2°C global warming threshold for hydrological changes over France.

References:

P-2205-03

Climate change will impact carbon balance of old-growth temperate rainforests of southern South America

A.G. Gutierrez (1)
(1) Universidad Austral de Chile, Instituto de Conservación Biodiversidad y Territorio, Valdivia, Chile

Understanding how forests might respond to climate change is important because of their role in storing and sequestering carbon, sustaining biodiversity, and providing ecosystem goods and services. There is a growing body of evidence indicating that ecological effects of climate change on forests are apparent and may vary among regions of the world. Little is known about future changes that climate change could exert on temperate rainforests of southern South America (SSA). Here, I present results of a process-based, dynamic forest model. The model integrates climatic variability and allows projecting forest responses to climate change in this region. Using this developed model, I projected hydroclimatic changes for Temperate rainforests of SSA given likely climate change scenarios. I focused on primary, old-growth temperate rainforests of SSA located on Chiloe Island (~42°S, Chile). Drier climate predicted for this century will alter forest content of the different layer of soil was assessed in sample plots. The result shows that the total amount of carbon stored in by Anogeissus pendula is higher than that stored by the other three forest type. The result also showed that the carbon storage is higher in thorn as compared to the deciduous trees in the region of low rainfall.
structure, leading to decreases in above ground biomass by 17% to current climate conditions, and mean net primary production will be reduced in ~30% for year 2100 (from 7.6 to 2.4 tC ha/year). As a result of warming alone, i.e. without accounting for the direct effects of climate change on forest pests and pathogens, temperate rainforests in SSA will become sources of carbon during this century (average among forest stands of ~3.7 tonnes of carbon -tC ha/year in 2100). These results inform the debate about forest pests as a feedback to future climate in SSA. Future research should focus in developing experimental and long-term monitoring still not available in this region. In the meantime, models provide a useful synthesis of current knowledge and future expectations for a region and can be used to provide additional information about the impacts of global change on hitherto overlooked regions of the world, such as southern temperate rainforests

ABSTRACT BOOK

Seepage Processes in Permafrost near a Hydro Unit in a Changing Climate

S. Milanovsky (1) ; S. Velikin (2)
(1) Institute of Physics of the Earth, Russian Academy of Science, Moscow, Russia; (2) Vilyui Permafrost Station of the Permafrost Institute, Krasnoyarsk branch, Chernishevskiy, Russia

Regular water and energy supply in permafrost areas are vitally important conditions for inhabitants of the large North territories of Russia, Canada, US and Alpine areas of Europe. Dam flank slope stability is the key to the service life of the reservoirs for safety of reservoir (power pool, water supply, tailing pit, etc.). In permafrost areas stability of many engineering structures, including hydraulic work, associated with thawing processes, is of essential importance. In recent years in the unit we have when seepage occurs in originated permeable talik zone adjoining to reservoir. We present original results of long-term geophysical study on hydro technical objects of Western Yakutia analyzing problems associated with use of geophysical methods for the study of rocks in permafrost areas. The primal problems of studies were focused to i) eliciting and checking of a possibility to use on dams and power reservoirs the specific filtration or deflection of water in a body of foundation and coastal contiguity of Sytikan dam and Bilui HPS (constructing and operating reservoirs) dams; ii) estimation of dynamics of seepage processes progressing processes for development of structures, directional on exception of losses of water from reservoir and supply of stability of a body of a dam. Due to a difficult and hardly predictable geocryological situation in this area, the geophysical methods were included into the system of local monitoring. From ground-level methods of studies in composition of operations were included high frequency electric profiling, evaluation of method on a mountain and their natural bed, georadar, seismic profiling, and seismic sounding. Down-hole observations on dams included long-term regime temperature measurements and complex of logging studies (resistance, flow meter sensors, gamma logging neutron gamma logging, caliper measurement, radio wave cross-borehole testing). On the ground of geophysical studies the detailed geological section was studied and the binding of seepage spacing to definite lithologic horizons was established. The purpose of geophysical investigations was, first, to control the thawing of frozen rock (talik) within the coastal zone of the reservoir and to assess the dynamics of the process, and second, to identify and to locate places of the most intense thawing and filtration of water from the reservoir. Alongside field studies, numerical evaluation of permeable talik zone (thawing) originating and development in the coastal zone around dam wall was made. The non-steady problem of heat-mass transfer in fractured-porous saturated frozen media, interbedded in frozen impermeable strata in the assessment considered the main conditions causing initiation and development of talik near a reservoir: annual temperature and snow cover variation, seasonal water temperature distribution with depth in the reservoir and their influence on permeability in rock due to thaw-freeze processes. The results of 2D heat-mass transfer modeling indicate that the development of talik formation depends on the specific thermal and hydraulic material parameters, thickness of the frozen layer covering talik and winter snow blanket insulating ground rocks, seasonal and global temperature trend as well as of presence of fractures in frozen rocks. It seems that proposed model can be used to analyze situations like rapid drainage of ice-rich permafrost-dammed lakes, Alpine frozen slope instability as well as the role of global temperature change influence on a system ‘ice-rich permafrost-aquifer’.

P-2205-05

The Challenges of Communicating Unwelcome Climate Messages

T. Rayner (1)
(1) Tyndall Centre for Climate Research, School of Environmental Sciences, Norwich, United Kingdom

As a recent report on communication of climate science has noted, “[t]here is widespread public acceptance of the reality of climate change, but not of the urgency and scale of the challenges that the science indicates it represents” (UCL 2014: 14). This discrepancy, the report suggests, derives from psychological factors and from cues from influential elites and the media. Communication efforts based on the linear-rational model have not sufficiently to motivate either publics or political decision makers. Better engagement of policymakers and society more generally with climate scientists and other experts, to evaluate scientific evidence and determine appropriate responses, requires new narratives to be found. With the probability that global temperature rise can be kept below the 2°C target continuing to diminish, the urgency of this task increases. How best to engage individual citizens and organisations with the kind of knowledge about the likelihood and implications of severe future impacts that few want to hear becomes an acute issue. How can adhesive narratives be encouraged by individuals, organisations and policymakers – rather than denial, fatalism and withdrawal? This paper presents the findings of a workshop organised to bring together climate scientists, social scientists, policymakers, consultants, communications specialists, psychologists, the private sector, the media and artists etc., to wrestle with the challenges of communicating findings from research into high impact scenarios, in a world where the 2 degrees limit is increasingly in doubt. As well as ‘the public’, the paper considers how best to engage with other audiences – particularly those who may not yet be in the habit of ‘climate proofing’ particular investments, and politicians and policy makers who would prefer to ignore the full, transformative implications of the climate crisis. It also reflects on the need to move discussion beyond the narrow framings offered by the geosciences, which tend to provide legitimacy and credibly to catastrophic framings that reinforce the message of climate change as ‘an unfolding, almost predetermined, disaster’ (O’Neill et al. 2010: 1000), to incorporate insights from a wider set of disciplines.


P-2205-06

How significant is the climate impact of Black Carbon?

BH. Samset (1) ; G. Myhre (2) ; Ø. Hodnebrog (2)
(1) CICERO, Climate System, Oslo, Norway; (2) CICERO, Oslo, Norway

Mitigation of Black Carbon (BC) aerosol emissions is an attractive policy option, due to co-benefits on climate and air quality. However, the climate impact of present day BC emissions is not well constrained.

BC interacts with the climate directly, through absorption and scattering of incoming sunlight; indirectly, through modification of cloud properties; and semidirectly, through modification of cloud properties; and semidirectly, through changes to atmospheric stability. To gauge the net effect of BC, these processes need to be well understood and coherently treated. Regional emissions of BC, and how it aggregates and is transported in the atmosphere, must also be known.

Since the publication of the IPCC AR5, several studies have indicated that the atmospheric lifetime of BC may be overestimated in present climate models. Through comparisons of flight measurement data with model calculations, both geographically and vertically, we show how models tend to overestimate BC concentrations.
aloth, where it has the strongest direct radiative forcing efficiency.

Other studies have improved our understanding of the semidirect effect of BC, which tends to counterbalance the positive direct forcing process. We show the vertical dependence of direct, semidirect and net BC forcing efficiency, and illustrate how the interaction of the direct and semidirect effects can lead to a virtually unchanged net BC forcing even for a doubling of emissions.

Based on these recent results, we here present an updated, holistic view of the present and historical climate impact of BC. To present policy relevant values of BC impact metrics, i.e. its radiative forcing per gram of emission, constrained by recent observations. We also argue that while further work is needed to constrain all mechanisms of BC-climate interactions, the remaining uncertainties, i.e. the role of absorbing aerosol particles in the tropopause, remain at most 1% and 5% level of significance, their absolute values were greater than the critical values (i.e. for CO2: -2.855384 > -3.610453 & -2.938987 and for rain: -1.591781 > -3.610453 & -2.938987). Also, the co-integration test was carried out in the long run; the trace statistic test revealed that at both 1% and 5% level of significance 2 and 1 equations were co-integrated. The Max-Eigen values also revealed that at both 1% and 5% level of significance, 2 and 1 equations were co-integrated, since their absolute values 25.27 > 15.41 and 20.04; 20.61 > 14.07 and 18.63. This corroborated the trace statistics, therefore, it was concluded that there is a long run equilibrium relationship between cocoa output and rainfall. The results established that the fact cocoa is highly susceptible to drought and the pattern of cropping of cocoa is related to rainfall distribution in the study area. Therefore, the study recommended that drought management policy through information systems about changing climate conditions and patterns, preparedness and options to deal with eventuality of drought must be set in place. The study examined whether or not there is short run and long run equilibrium relationship between cocoa output and climate change variables (i.e. Rainfall, Temperature and Humidity). This is to ascertain the effect of climate change on cocoa output both in the short run and long run in the study area. The short run was considered to be within the period of 1971–1990 and 1990–2010, while the long run was considered to be within the period of 1971–2010. It was established at the long run that cocoa output and rainfall were non-stationary among the three selected climate change determinants (i.e. Rainfall, Humidity and Temperature.). In the long run, both at 1% and 5% level of significance, their absolute values were greater than the critical values (i.e. for CO2: -2.855384 > -3.610453 & -2.938987 and for rain: -1.591781 > -3.610453 & -2.938987). Also, the co-integration test was carried out in the long run; the trace statistic test revealed that at both 1% and 5% level of significance 2 and 1 equations were co-integrated, since their absolute values 25.27 > 15.41 and 20.04; 20.61 > 14.07 and 18.63. This corroborated the trace statistics, therefore, it was concluded that there is a long run equilibrium relationship between cocoa output and rainfall. The results established that the fact cocoa is highly susceptible to drought and the pattern of cropping of cocoa is related to rainfall distribution in the study area. Therefore, the study recommended that drought management policy through information systems about changing climate conditions and patterns, preparedness and options to deal with eventuality of drought must be set in place.

P-2205-08

The Effect of Climate Change on Cocoa Production in Ekiti and Ondo States of Nigeria: A Co-Integration Analysis

O. Thompson (1)
(1) The Federal University of Technology, Akure, Ondo State, Nigeria, Agricultural and Resource Economics, Akure, Ondo, Nigeria, Federal Republic of

The study examined whether or not there is short run and long run equilibrium relationship between cocoa output and climate change variables (i.e. Rainfall, Temperature and Humidity). This is to ascertain the effect of climate change on cocoa output both in the short run and long run in the study area. The short run was considered to be within the period of 1971–1990 and 1990–2010, while the long run was considered to be within the period of 1971–2010. It was established at the long run that cocoa output and rainfall were non-stationary among the three selected climate change determinants (i.e. Rainfall, Humidity and Temperature.). In the long run, both at 1% and 5% level of significance, their absolute values were greater than the critical values (i.e. for CO2: -2.855384 > -3.610453 & -2.938987 and for rain: -1.591781 > -3.610453 & -2.938987). Also, the co-integration test was carried out in the long run; the trace statistic test revealed that at both 1% and 5% level of significance 2 and 1 equations were co-integrated. The Max-Eigen values also revealed that at both 1% and 5% level of significance, 2 and 1 equations were co-integrated, since their absolute values 25.27 > 15.41 and 20.04; 20.61 > 14.07 and 18.63. This corroborated the trace statistics, therefore, it was concluded that there is a long run equilibrium relationship between cocoa output and rainfall. The results established that the fact cocoa is highly susceptible to drought and the pattern of cropping of cocoa is related to rainfall distribution in the study area. Therefore, the study recommended that drought management policy through information systems about changing climate conditions and patterns, preparedness and options to deal with eventuality of drought must be set in place.
wind speed, solar power by changes in solar irradiance and temperature, alteration of the hydrological cycle with temperature increase could impact both the potential for hydropower and the availability of cooling water for thermo-electric power plants. On the demand side, temperature increase will reduce electricity demands for heating while the use of air-conditioning is expected to increase. This study aims at investigating the potential impacts of climate change on the European electricity sector by integrating the different effects of changes in climate variables on wind and solar photovoltaic power, thermo-electric and hydropower supply along with the effects on electricity demand. Climate information is taken from a multi-model ensemble of high-resolution regional climate model projections (Cordex) over Europe. Impact models are then used to compute changes in power generation and demand due to changes in climate variables. Several electricity variables are considered (current mix, contrasted mix scenarios). The assessment is conducted for a +2°C and a +3°C global warming to quantify the impact of climate change limited or not to the +2°C target.

This study has been carried out in the framework of the European FP7 project IMPACT2C.

**P-2205-10**

**Space-time distribution of China’s water resources under the global climate change**

H. Xia (1)

(1) East China Normal University, School of geographic sciences, Shanghai, China

The water resource is the basic proposition of agricultural and industrial development in China because of our big population. It is noteworthy that what climate change will effect on Chinese future water resource. The influence of climate change includes precipitation and evaporation, of which the former is more discussed and the latter is readily ignored. This article is based on the regional climate model (RegCM4) which is developed by NCAR/PSU (National Center of Atmospheric Research/University of puff) and the state climatic administration of Ministry of Resources and Environment. We made a simulation to estimate the future climate change in China with A1B scenario. And got the spatial distribution characteristics of temperature and precipitation in historical period (1981–2000 average annual value) and future period (2041–2060 average annual value). The P–M evapotranspiration model recommended by the FAO is used to calculate the evaporation. And the moisture degree is used as the index of water resources. In general, the results showed that water resources in China present latitude zonal distribution, gradually reduce form south to north. From the trend of the change, the water resources in the south of Yangtze river will decrease in the future. In the north and the north of Yangtze river especially in the north of the Huai–He river, the water resources condition will get better. The most obvious regions for the growth of water resources include the western of northeast China, Huai–He river basin, Si–chuan province and the south of Tibetan autonomous region.

**P-2205-11**

**Better Representation of Climate Change Impacts from Multi-model Ensembles**

J. Zaherpour (1); S. Gosling (2); N. Mount, (1); R. Dankers, (3); Y. Masaki (4); I. Haddeland (5); T. Stacke, (6); J. Heinke, (7); S. Eisner, (8); M. Flörke, (9); B. Fekete, (9); Y. Wada, (10); L. Warszaposki (7); J. Schewe, (11); K. Frieler, (7); P. Piontek, (7); V. Huber, (7)

(1) University of Nottingham, Nottingham, United Kingdom; (2) University of Nottingham, School of Geography, Nottingham, Nottinghamshire, United Kingdom; (3) Met Office, Exeter, United Kingdom; (4) Center for Global Environmental Research, Tsukuba, Japan; (5) Norwegian Water Resources and Energy Directorate, Oslo, Norway; (6) Max–Planck–Institute for Meteorology, Hamburg, Germany; (7) Potsdam Institute for Climate Impact Research, Potsdam, Germany; (8) Center for Environmental Systems Research, University of Kassel, Kassel, Germany; (9) Civil Engineering Department, The City College of New York, New York, United States of America; (10) Department of Physical Geography, Utrecht University, Utrecht, Netherlands; (11) Potsdam Institute for Climate Impact Research (PIK), Potsdam, Germany

We present an innovative application of intelligent computing that constrains simulations of river discharge from an ensemble of multiple global hydrological models (GHMs) against observations for 110 large catchments across the globe to provide a single estimate of discharge that is both more robust and better informed than more traditional, simplistic techniques such as the ensemble mean. The approach uses evolutionary algorithms (EAs) through symbolic regression (SR) to develop catchment-specific multi–model combination (MMC) solutions that combine simulated discharge values from seven GHMs participating in ISI–MIPI (Inter-sectoral Impact Model Intercomparison Project). The MMC algorithms are optimised by evaluating individual models (GHMs) performance against observations and then weighting and/or discounting GHMs accordingly in the MMC. In addition, the performance of the ensemble mean in simulating the observations is explored. A numerical integrated metric, ideal point error (IPE) with the privilege of assessing different behavioural aspects of the models simultaneously, is used to measure the performance of GHMs, MMC technique and ensemble mean approaches. Comparisons between simulated and observed discharge show that the optimised MMC algorithms can outperform the simulations of discharge from the best performing GHMs by reducing simulation error up to a magnitude of 30%. The MMC technique can outperform the ensemble mean method in virtually all of the 110 catchments. Our analyses demonstrates the value of evaluating climate change impact model performance and using the results to provide guidance on the selection of the most appropriate model from multi–model ensembles that are more informative than traditional ensemble averaging techniques.

**ORAL PRESENTATIONS**

**K-2206-01**

**The Sustainable Development Pathway**

J. Sachs (1)

(1) Columbia University, Earth institute, New York, United States of America

The world has several partial pathways towards sustainable development that cover specific areas, such as agriculture or climate change. Yet, we do not have an integrated pathway that demonstrates how the economic, social, and environmental imperatives of sustainable development can be achieved in harmony with one another. Such a pathway would inter alia have to stay within global “planetary boundaries”, allow all countries to meet national development objectives, and maintain social inclusion.

Moreover, a global pathway will need to be downscaled to major regions and demonstrate that every region can achieve sustainable development.

Working with my collaborators on “The World in 2050” we will partner with major modeling organizations to establish an integrated sustainable development pathway. We will use the Sustainable Development Goals proposed by member states of the United Nations as a shorthand form of objectives for sustainable development.

This presentation will focus on the economics of sustainable development. A key research question is how mid- to longer-term economic models can incorporate the SDGs. This will be illustrated using a few examples from the emerging research.
K-2206-02

The World in 2050
J. Rockström (1) ; E. Kriegler (2) ; K. Riahi (3)
(1) Stockholm Resilience Center, Stockholm University, Stockholm, Sweden
(2) Potsdam Institute for Climate Impact Research, Potsdam, Germany
(3) International Institute for Applied Systems Analysis, Energy Program, Laxenburg, Lower Austria, Austria

One of the most pressing issues facing the global community post 2015 is how to realize the benefits of future global economic development within a safe and just operating space of a stable planet.

The World in 2050 Project will explore the implications of the necessary transformative sustainable development pathways and the possible 'degrees of freedom' to meet economic development goals within a safe operating space of a stable planet.

The project will generate the 1st generation of scenarios that meet the twin objectives of economic growth and planetary stability and thus provide improved evidence, including macro-economic assessments, to political leaders in the SDG process, and other key decision makers, on the feasibility, challenges and opportunities associated with meeting long-term development goals, i.e., development goals that are truly sustainable at a global scale.

K-2206-03

Beyond Paris to 2050 and thereafter - multiple benefits of a global transformation toward sustainable futures
N. Nakicenovic (1)
(1) International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria

An objective of The World in 2050 Initiative is to explore the transformative development pathways at the global and regional scales that achieve convergent economic and social development within planetary boundaries. The presentation will focus on the main drivers of the transformation, their relationships including some of the Sustainable Development Goals (SDGs) and their targets, on policy measures, and on technological and social changes that would be needed for achieving the transformation toward the "safe and just space" that characterizes sustainable futures.

An important research question is how high are the degrees of freedom in achieving this transformation, what are the prerequisites and implications. In other words, are there multiple transformative pathways especially at national levels? For example, Global Energy Assessment (GEA) developed 41 transformative energy pathways toward sustainable energy futures that included universal access to energy services for all, improvements in energy efficiency and decarbonization needed to stabilize climate change at two degrees Celsius above pre-industrial levels. Energy is one of the SDGs, but the challenge is to assess to what extent different SDGs, such as energy and water, can enhance each other and to what extent tradeoffs will be required in achieving different SDGs.

Finally, the presentation will conclude by assessing multiple benefits and opportunities that would emerge from the transformative changes toward sustainable futures. A key question to explore is the potential for achieving co-benefits and/or trade-offs of addressing multiple SDGs at the same time, which can provide critical information for policy and investment decisions, their synergies and possible conflicts among them.

K-2206-04

The World in 2050 – the contribution of model-based scenarios
D. Van Vuuren (1) ; E. Kriegler (2) ; K. Riahi (3)
(1) PBL Netherlands Environment Agency, PBL, Climate, air pollution and energy, Bilthoven, Netherlands
(2) Potsdam Institute for Climate Impact Research, Potsdam, Germany
(3) International Institute for Applied Systems Analysis, Energy Program, Laxenburg, Lower Austria, Austria

In 2012, governments worldwide renewed their commitments to a more sustainable development that would eradicate poverty, halt climate change and conserve ecosystems, and initiated a process to create a long-term agenda of action by formulating Sustainable Development Goals (SDGs). These SDGs will be agreed upon in 2015. Studies that depict pathways that relate near-term actions and a long-term vision could help implementing the SDGs by 1) providing a link between the 2030 SDG targets and an inspirational vision about a sustainable world in 2050 to a medium-term set of sustainable development goals (say by 2025 or 2030), 2) exploring what efforts would be needed to realize the goals and 3) providing information on the inter-linkages (synergies and trade-offs) between the achievement of the goals.

Integrated assessment models have been used extensively in the last few years to develop model-based scenarios to depict possible future trajectories with respect to human development and environmental consequences. They have also been used to develop scenarios that achieve certain future goals (e.g. the 2°C climate target). Most of these studies have looked into specific topics, but there has also been studies that took a broader set of goals comprising both environment and development targets such as the Global Energy Assessment, the Global Environmental Outlook and the study "Roads from Rio+20". Overall, these studies have shown that it is possible to achieve an ambitious set of sustainable development targets simultaneously. However, this will require fundamental changes in the energy and food system. There are also important synergies and tradeoffs between different objectives that depend on the specific strategies that are used to achieve them (e.g. specific technologies, different types of management and the role of lifestyle changes).

In the proposed presentation, we will discuss how integrated assessment models can provide further insights into the question how to achieve the a set of sustainable development objectives (including the SDGs) in the 2030 / 2050 period, among others by using specific examples from existing studies. We will also discuss how the Shared Socio–Economic Pathways (SSPs) can be used within the context of such an exercise.

K-2207-01

Ecological challenges for life in a rapidly changing ocean
J.P.Gattuso (1) ; T. Ocean 2015 Initiative (2)
(1) CNRS and Université Pierre et Marie Curie, Laboratoire d’Océanographie de Villefranche, Villefranche-sur-mer, France
(2) Institut du développement durable et des relations internationales, Paris, France

Ocean warming and acidification share the same primary cause, which is the increase in atmospheric CO2. The fossil record indicates that the rate and magnitude of the present, human–generated carbon perturbation leads to changes potentially unparalleled in the last 300 My of Earth history. Ocean warming and acidification are two key global environmental drivers that challenge marine organisms and ecosystems. Responses can be influenced, often exacerbated by other drivers, such as hypoxia, eutrophication, habitat loss and overexploitation of resources.

A large range of approaches are used to assess the present impacts and project future risks: paleo-observations,
observations in natural gradients and around CO2 vents, provide improvements in the field, as well as modelling. All approaches indicate that the effects of ocean warming and acidification on individual organisms are or will be widespread, and that they impact ecosystem level processes and at the regional scale. Corals, for example, induce shifts in the abundance, geographic distribution, migration patterns, and timing of seasonal activities of species, generating changes in the composition of ecosystems. Such distributional shifts will continue in the coming decades, increasing species richness at mid- and high latitudes and decreasing it at tropical latitudes. This will result in a global redistribution of catch potential for fishes and invertebrates, with implications for food security. A wide range of sensitivities to projected rates of ocean acidification exists within and across diverse groups of organisms, with a trend for greater sensitivity in early life stages. A pattern of positive and negative impacts emerges. The rate of calcification decreases in most, but not all, sea floor calcifiers such as reef–building corals, coralline algae, bivalves, and gastropods, reducing the competitive success of non–calcifiers. The combined effects of ocean warming and acidification have resulted and will further result in changing interactions between species, including competition, predation and pathogen dynamics.

A considerable number of biological, chemical, and physical processes act at enormous ranges of space and time: biological processes, respectively, processes and interactions are understood because most studies are short–term, organism–centric and examined just one driver at a time. Gaps in our understanding and uncertainty in future projections therefore remain. Coral reefs are the main ecosystem which already exhibits prominent signs of the impact of climate–related variables but it must be pointed out that seemingly stable ecosystems that are maintained feeding mechanisms are subject to abrupt ecological shifts. Taken together, these observations as well as the fossil record confirm links between ocean warming and acidification and responses of ocean ecosystems. There are no plausible alternatives to immediate, deep reduction of greenhouse gases emissions for limiting future ecological challenges and maintaining ocean services. It should be emphasised that reduction of emissions to address ocean acidification will simultaneously address climate change but reducing emissions of other greenhouse gases to limit warming will not necessarily address ocean acidification.


K-2207-02
Climate change and the Ocean: regional challenges and opportunities
O. Hoegh-Guldberg (1); T. Ocean 2015 Initiative (2)
(1) University of Queensland, Global Change Institute, Brisbane, Australia; (2) Institut du développement durable et des relations internationales, Paris, France

Earth’s ocean plays a central role in its climate, absorbing 93% of the extra heat from the enhanced greenhouse effect and approximately 30% of the CO2 emitted by burning of fossil fuels and land use change. While these contributions play an important role in reducing the rate of change in the average global temperature, they have consequences for key variables such as marine productivity and chemistry, and consequently a wide range of other key variables such as surface salinity, wind, pH, carbonate chemistry, stratification, ocean currents, nutrient availability, and species distributions. According to the IPCC we are now seeing changes in ocean conditions that are unprecedented, which in the case of ocean acidification, are “unprecedented within the last 65 Ma (high confidence) if not the last 300 Ma (medium confidence).”

These rapid changes within the Ocean are affecting the distribution and abundance of organisms and ecosystems, with important consequences for the goods and services that the Ocean provides to communities and nations worldwide. Fisheries and ocean–related livelihoods play important role in the lives of at least 3 billion people globally, with many nations receiving more than half of the protein requirements from the Ocean. While often overlooked in terms of national accounts, contributions by the ocean to key issues such as food security, employment, health, and coastal protection are large and are only likely to become more important over coming decades. Consequently, the ocean will respond to warming induced changes posied by a changing ocean is critically important in terms of adaptation challenges and opportunities.

A regional analysis of climate change reveals a range of responses by ocean ecosystems. Recent changes to wind and ocean mixing are influencing the transfer of organic carbon to deep regions, which has had knock–on effect of stimulating oceanic respiration, and reducing the amounts of CO2 that the ocean will be able to store in the future. There is considerable evidence and agreement that fisheries in regions such as the High Latitude Spring Bloom Systems (HLSSB) in the North–East Atlantic are changing in response to warming and ice retreat, with both positive and/or negative implications depending on the particular HLSSB fishery. Other fisheries are relocating at a high rate, placing stress on regional management.

Equatorial upwelling systems (EUS) which support highly productive fisheries off Equatorial Africa and South America, have warmed significantly over the past 60 years. While warming is consistent with changes in upwelling intensity, more work is needed to understand how EUS will change in response to warming over time. The regional analysis of climate change reveals a range of responses by ocean ecosystems. While changes are occurring, there is a need for careful management of these changes and their implications for ecosystem services. The risks, however, a significant given the importance of the ocean to key issues such as food security, employment, health, and coastal protection are large and are only likely to become more important over coming decades. Consequently, the ocean will respond to warming induced changes posied by a changing ocean is critically important in terms of adaptation challenges and opportunities.

The regional analysis of climate change for ocean systems reveals an important yet poorly understood source of risk and vulnerability for the world’s nations. As a consequence, there is a need for the world’s nations to address these information gaps, and pursues otherwise poorly developed adaptation options, especially in terms of building socio–ecological resilience for the large number of exposed nations. Establishing communities of practice, knowledge and solutions platforms, as well as creating an alliance of nations around the challenges posed by a rapidly changing ocean will only grow in importance over the coming decades and century.


O-2207-01
Climate sensitivity across marine domains of life: limits to evolutionary adaptation shape species interactions
D. Storch (1) ; L. Menzel, (1) ; S. Frickehaus (2) ; HO. Pörtner (3)
(1) Alfred–Wegener–Institut Helmholtz–Zentrum für Polar– und Meeresforschung, Integrative Ecophysiology, Bremerhaven, Germany; (2) Alfred–Wegener–Institut Helmholtz–Zentrum für Polar– und Meeresforschung, Scientific computing, Bremerhaven, Germany; (3) Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany

Organisms in all domains Archaea, Bacteria, and Eukarya will respond to climate change with differential vulnerabilities resulting in shifts in species distribution, coexistence, and interactions. The identification of universal principles of climate responses across all marine domains would facilitate a cause and effect understanding of such changes and their implications for ecosystem shifts. For example, the functional specialization of all organisms in limited temperature ranges leads us to ask for unifying functional reasons. Organisms also specialize in either anoxic or various oxygen ranges, with animals and
plants depending on high oxygen levels. Here, we identify thermal ranges, heat limits of growth, and critically low (hypoxic) oxygen concentrations as proxies of tolerance in a meta-analysis of data available for marine organisms, with special reference to domain-specific limits. For an explanation of these differences and differences observed on the phylogenetic scale, we define and quantify a proxy for organic complexity across species from all domains. Rising complexity causes heat (and hypoxia) tolerances to decrease from Archaea to bacteria and then to unicellular eukaryota. Within and across domains, taxon-specific tolerance limits likely reflect ultimate evolutionary limits of its species to acclimatization and adaptation. We hypothesize that rising taxon-specific complexity limits are fundamental to our understanding of constraints to narrower environmental ranges. Low complexity as in Archaea and some Bacteria provide life options in extreme environments. In the warmest occurs, however, increased complexity will surpass the permanent limits to the existence of multicellular animals, plants and unicellular phytoplankter. Smaller, less complex unicellular eukaryota, Bacteria, and Archaea will thus benefit and predominate even more in a future, warmer, and hypoxic ocean.

O-2207-02

Differential synergistic adverse effect of increased sea temperature and acidity on corals

P. Fantazzini, (1) ; F. Prada (2) ; E. Caroselli, (2) ; B. Capaccioni, (3) ; S. Mengoli, (4) ; L. Pasquini, (5) ; O. Levy, (6) ; C. Weickert, (7) ; KE. Fabricius, (8) ; Z. Dubinsky, (6) ; G. Falini, (9) ; S. Goffredo, (2)

(1) Centro Fermi and University of Bologna, Department of Physics and Astronomy, Bologna, Italy; (2) University of Bologna, Marine science group, dep of biological, geol and environmental sciences, section of biology, Bologna, Italy; (3) University of Bologna, Department of biological, geological and environmental sciences, section of biology, Bologna, Italy; (4) University of Bologna, Department of management, Bologna, Italy; (5) University of Bologna, Department of physics and astronomy, Bologna, Italy; (6) Bar-Ilan University, The mina and everard gourmet faculty of life sciences, Ramat-Gavion, Israel; (7) Harvard University, Wyss institute for biologically inspired engineering, Cambridge, United States of America; (8) Australian Institute of Marine Science, Pmb 3, Townsville, Australia; (9) University of Bologna, Department of chemistry “g. ciancioan”, Bologna, Italy

Global climate change is predicted to affect marine organisms and ecosystems reliant on the accumulation of calcium carbonate structures, as coral reefs, potentially reducing the socioeconomic benefits these habitats provide. In the marine realm, two of the main stressors causing significant changes are ocean warming and ocean acidification.

Projections of future climatic change estimate a 0.6–2.0°C average increase in surface ocean temperature by the end of the 21st century, a major threat for marine organisms. In temperate areas, the effect of warming is expected to be even greater. The Mediterranean Sea is already showing warming rates three times higher than the global ocean. Increased seawater temperature in the Mediterranean Sea has determined longer stratification periods associated with mass mortality events. The first well-documented Mediterranean multispecies mass mortality events were due to elevated pH in the 1980s. In both cases, a positive correlation was observed between mortality rates and exposure to heat stress, indicating that shallow water corals are not well adapted to living, at least in the cold water Mediterranean near their upper thermal limits during summer. Since then, the frequency of abnormally warm summers is expected to increase in the next century, as a result of climate change, such mortality events in summer may also become more frequent as a direct response to elevated temperatures.

Also ocean acidification is a global phenomenon which impacts species diversity. The Mediterranean Sea has experienced a pH decrease of up to 0.14 units since the pre-industrial era, larger than the global average surface ocean pH decrease. Hence, understanding how enhanced acidity has already affected and will further affect Mediterranean Sea ecosystems and their key taxa is urgent and crucial. Given the projected decrease of seawater pH, the mass mortality events could be exacerbated by the combination of high temperatures and low pH. Studies like this one, assessing the synergistic interaction between low pH and elevated temperatures for the first time, provide crucial insights into the interactions between multiple stressors and establish to which extent corals inhabiting shallower ranges will be threatened by climate change.

Here we assessed the combined effects of situ exposure to different acidity and seasonal temperatures on the mortality and growth rates of three Mediterranean scleractinian corals. The solitary azooxanthellate Balanophyllia europaea, the solitary azooxanthellate Leptopsammia pruvoti and the colonial azooxanthellate Astridiole calcarinula. The corals were transplanted and observed in different continuous and intermittent treatments in proximity to a volcanic vent where water is naturally acidified to levels matching different future Intergovernmental Panel on Climate Change scenarios.

The results suggest differential synergistic adverse effects of increased sea temperature and acidity and different levels of resilience/resistance to climate change among temperate coral species, probably related to different modes of nutrition and/or biomineralization processes, making symbiotic species relatively less sensitive due to the increased photosynthesis at high CO2.

Acknowledgements: The research leading to these results has received funding from the European Research Council under the European Union’s 7th Framework Programme (FP7/2007–2013)/ERC grant agreement n° 249930 – CoralWarm: Corals and global warming: the Mediterranean versus the Red Sea.

O-2207-03

Rising reef carbonate dissolution due to bioreworking microflora under climate change - an overlooked buffer process?

J. Grange (1); A. Tribollet (2); P. Cuet (3); H. Rybczyncky (4); A. Chauvin (3); M. Atkinson (5)

(1) UPMC, Ipa–locan, Paris, France; (2) IRD, Ipa–locan, Paris, France; (3) Université de la Réunion, Entropie, Saint Denis, La Réunion, France; (4) UPMC, Borea, Paris, France; (5) HIBM, Kaneohe, United States of America

Since the industrial era, the atmospheric partial pressure of CO2 (pCO2) has been rising. Consequently, the world’s ocean is getting warmer and acidified. By the end of the century, IPCC models in the worst case scenario predict an increase of sea surface temperature of 4°C and a decrease of seawater pH estimated at 0.3–0.4 pH-units. As a consequence, these changes in surface ocean chemistry (CO2, Ω) with respect to calcium carbonate minerals (CaCO3) will also decrease. All these climatic factors are expected to affect calcification and dissolution processes, putting for instance in jeopardy coral reef ecosystems which are entirely made of carbonates. Among those processes, biogenic dissolution of carbonates due to bioreworking microflora (or eudolithons), which comprise cyanobacteria, algae and fungi has received some attention over the past decade and is currently not taken into account in biogeochemical models. So far, rates of biogenic dissolution were estimated by quantifying the volume of calcium carbonate removed by bioreworking filaments using microscopy observations. Although those rates are significant (up to 1.1 kg CaCO3 dissolved per m² per year in coral reefs), the question is how much alkalinity is being released in the ocean, and how they are influenced by climate change (pH and temperature). In addition, all experiments recently carried out which highlighted the positive effects of ocean warming and acidification on biogenic dissolution, were realized under controlled conditions (mesocosms) in tropical regions over short periods of time (2–3 months). The long term dynamics of the process of biogenic dissolution under natural conditions remains poorly known. Here we present results of five experiments carried out in tropical (Hawaii, New Caledonia reefs) and temperate regions (Ischia in Italy) at different time scales (2–3 months) to show how the alkalinity produced by bioreworking microflora is significant (as high as 71 mequiv m–2 d–1 which converts to a CaCO3 dissolution rate of 1.3 kg m−2 y−1 under constant light conditions in tropical regions), biogenic dissolution can occur under various saturation states (0.8 ≤ Ω ≤ 5 both in temperate and tropical regions) and increases under rising pCO2 (by 50% to 250% depending on conditions) as long as the saturation state is above 1 (otherwise carbonate dissolution due to chemical conditions limits eudolith development and thus, biogenic dissolution), and (3)
From natural science to management: Pteropods as sentinel species for OA waters status assessments

N. Bednarsek (1); T. Klinger (2); R. Feely (3)

(1) University of Washington, School of marine and environmental affairs, Seattle, WA, 98105, United States of America; (2) University of Washington, School of marine and environmental affairs, Seattle, WA, 98105, United States of America; (3) Pacific Marine Environmental Laboratory, Noaa, Seattle, WA, 98115, United States of America

Pteropods are ubiquitously distributed pelagic marine zooplankton of importance in productive upwelling and high latitude ecosystems, where they represent an important prey item for variety of economically, ecologically, and culturally important fish species. Because of their extreme sensitivity to ocean acidification (OA) conditions, pteropods can be used to establish causal and effect relationships between OA status and biological condition. As a result, pteropods can be used as a robust bioindicator for use in OA assessment. To demonstrate this utility, newly developed methods were used to determine and quantify pteropod responses in the natural environment. Biological responses, such as shell dissolution, shell calcification, changes in vertical distribution, and survival success were accounted for to establish pteropod condition under a variety of OA conditions. We used modelling to estimate population survival rates based on future regional ocean acidification scenarios and to determine the level of sampling required to make robust conclusions. We found that pteropod models provide a repeatedly quantifiable measure that can be used as a rapid and cost-effective biomarker to monitor biological response to ocean acidification conditions across scales of time and space of relevance to managers.

Ocean acidification and its relevance to the United Nations Framework Convention on Climate Change in Paris in December 2015

C. Turley (1); P. Williamson (2); D. Herr, (3); K. Isenee (4); E. Harrould-Kolieb (5)

(1) Plymouth Marine Laboratory, Plymouth, United Kingdom; (2) University of East Anglia, School of Environmental Sciences, Norwich, England; (3) International Union for Conservation of Nature, Bonn, Germany; (4) IOC–UNESCO, Ocean Science Section, Paris, France; (5) University of Melbourne, School of Geography, Melbourne, Vic, Australia

Ocean acidification is a relatively recently recognised process that has developed as a result of human activities, and is growing rapidly over the last few years. It is caused by anthropogenic carbon dioxide emissions and it has the potential for widespread, damaging effects on marine ecosystems that will also impact human society. It therefore must be part of the debate on emissions reduction at the international scale. However, it has been proposed. However, this is unrealistic, as there is likely to be little interest among states to do so. In light of this, this paper explores the idea of using iron fertilisation as a policy tool to mitigate ocean acidification by proposing the parsing out of activities needed to respond to ocean acidification across a range of existing multilateral environmental agreements (MEAs), overseen by an umbrella body and thereby forming a coordinated ocean acidification regime complex.

MEAs, Mandates and More – A coordinated regime complex for ocean acidification

E. Harrould-Kolieb (1)

(1) The University of Melbourne, School of Geography, Melbourne, Vic, Australia

Ocean acidification, a complex global issue, results from the emission of anthropogenic carbon dioxide (CO2) and is exacerbated by global warming. While the potential consequences are not limited by geography and largely occur in an area of the global commons, it has uneven impacts, results in both ecological winners and losers and occurs in an area of the global commons. It has uneven impacts, results in both ecological winners and losers and is likely to be a contributing factor in the apparent lack of action to mitigate and further respond to ocean acidification (Kim 2012, Herr et.al. 2014). As it currently stands, no single treaty or international instrument has been established to address ocean acidification as a stand-alone issue.

In response to the apparent lack of policy action on ocean acidification, the development of a completely new comprehensive treaty to respond to ocean acidification has been proposed. However, this is unrealistic, as there is likely to be little interest among states to do so. In light of this, this paper explores the idea of using iron fertilisation as a policy tool to mitigate ocean acidification by proposing the parsing out of activities needed to respond to ocean acidification across a range of existing multilateral environmental agreements (MEAs), overseen by an umbrella body and thereby forming a coordinated ocean acidification regime complex.
mandate, and finds that ocean acidification falls within its purview, and hence proposes ways to better incorporate OA across its workings.

P-2207-02

« Bridging the Gap between Ocean Acidification Impacts and Economic Valuation »

N. Hilmi (1); S. Reynaud (1); M. Marc (2); L. Hansson (3); P. Batra (3); D. Osborn (4); D. Allemand (5)

(1) Centre Scientifique de Monaco, Environmental Economics, Monte-Carlo, Monaco; (2) IAEA, Radiology, Monte-Carlo, Monaco; (3) IAEA, locc, Monte-Carlo, Monaco; (4) IAEA, Director, Monte-Carlo, Monaco; (5) Centre Scientifique de Monaco, Director, Monte-Carlo, France

Ocean acidification is a growing environmental concern. The chemistry and therefore biology of the world oceans will be profoundly perturbed by increasing atmospheric levels of carbon dioxide (CO2). This perturbation study in different regions of the world. Social and economic impacts of ocean acidification have the potential to seriously impact coastal communities and their economies. Communities ranging from mega-cities to subsistence fishing villages differ significantly in population, maritime activity, reliance on marine natural resources and therefore their respective adaptability. Identifying the magnitude and type of impacts ocean acidification will have on communities will become a concern of governments of coastal countries seeking to maintain current marine activities and benefits.

In 2008, the Monaco Declaration (requested by HSH Prince Albert II) advocated for the development of links between economists and scientists in order to better evaluate the socioeconomic impacts of ocean acidification. In line with the Monaco Declaration and in accordance with the wishes of Prince Albert II, an International workshop series « Bridging the Gap between Ocean Acidification Impacts and Economic Valuation » was launched by the ‘Centre Scientifique de Monaco’ and the Environment Laboratories of the IAEA. Three workshops have been organized since 2010 all gathering multidisciplinary international experts, to identify ways to model the cascade of potential impacts ocean acidification will have on human activities. These workshops resulted in clear conclusions and recommendations for policy makers.

The first workshop (2010) focused on the impacts of ocean acidification on the global economy. For the first time, economists and scientists came together to open the lines of communication and foster cooperation and coordination. The second workshop (2012) focused on impacts of ocean acidification on fisheries and aquaculture in different regions of the world. Social and economic impacts of ocean acidification on livelihoods, commerce and food security were discussed. What are the socioeconomic impacts of ocean acidification on coastal communities? The third workshop (2015) discussed impacts on major coastal fisheries and tourism activities, and considered ways to model the cascade of potential impacts of ocean acidification on human activities. The workshop also discussed potential adaptation and capacity-building options and policy responses available to these various sectors and governments. Each of the workshops provided a set of specific recommendations for policy makers, together with possible mitigation and adaptation measures, and research priorities.

P-2207-03

Response of the Eastern Mediterranean planktonic ecosystem to elevated CO2 and temperature: results from a mesocosm perturbation study

E. Kraskaopoulou (1); P. Pitta (2); C. Frangoulis (2); L. Al-Moosawi (3); A. Giannakourou (4); A. Lagaria (2); N. Papageorgiou (5); S. Psarra (2); E. Souvermezoglou (4); T. Tsiola (1); C. Papageorgiou (5); N. Hilmi (1); S. Reynaud (1); M. Marc (2); L. Hansson (3); P. Batra (3); D. Osborn (4); D. Allemand (5)

(1) University of the Aegean, Department of Marine Sciences, University Hill, 81 100 Lesvos, Greece; (2) Hellenic Centre for Marine Research, Desertification and carbon cycle of ocean ecosystems, P.O. Box 712, 71003 Heraklion, Greece; (3) Plymouth Marine Laboratory, Prospect Place, West Hoe, Plymouth PL1 3DH, United Kingdom; (4) Hellenic Centre for Marine Research, Institute of oceanography, P.O. Box 712, 19013 Anavissos, Greece; (5) Hellenic Centre for Marine Research, Institute of marine biology, biotechnology and aquaculture, P.O. Box 2214, 71003 Heraklion, Greece; (6) CNRS–INSU University Paris6, Laboratoire d’oceanographie de Villefranche, F–06230 Villefranche Sur Mer, France; (7) Institute of Environmental Science and Technology (ICTA), Universitat Autònoma de Barcelona, Bellaterra (Barcelona), Spain

One of the most important challenges is to bridge the gap between ocean acidification and the economic impacts on the planktonic ecosystem of the Eastern Mediterranean. A mesocosm experiment took place from August 2010 to September 2013 at the mesocosm facilities of HCMR in Crete, in the framework of the EU funded MedSea project (www.medsea-project.eu). Natural plankton assemblages were incubated in 3 m3 mesocosms to examine the impact of changes in carbonate chemistry and temperature on biogeochemical variables and processes.

Two different pCO2 levels (present and predicted for year 2100) were applied in the mesocosms for 2 weeks and tested in two large concrete tanks with different temperatures (ambient seawater: 25°C, ambient +3°C: 28°C). Four triplicates of mesocosms were deployed simulating the conditions of: current temperature and pCO2 (served as Control; C), Ocean Acidification (OA), Warming (W) and Greenhouse (GH).

The control of temperature in the two large tanks was made by means of a heating and cooling system connected to a central controller. Temperature was successfully controlled, exhibiting a nycthemeral variation of less than ±0.5°C of the target temperature throughout the experimental period. The “acidified” conditions were achieved by adding CO2 saturated seawater during three consecutive days at the start of the experiment and then were left to evolve due to biological activity and air/sea exchanges of CO2 till the end of the experiment.

The effect of acidification was evident in the Chl-a concentration (highly dominated by the pico-sized fraction) and also in the pico-eukaryote density. Chl-a and pico-eukaryotes increased in both acidified treatments, whereas primary production was likely more dependent on temperature than OA. Bacterial abundance and production were not or only slightly affected by OA or W. OA caused a slight effect of no effect of warming (even combined with acidification) on bacterial abundance; however a slight effect of temperature on bacterial production was observed. The effect of pCO2 was highest in the GH conditions, while it remained suppressed at lower levels in the GH mesocosms. No significant differences were measured for the phosphate turnover time between treatments, while the carbon in all treatments for the duration of the experiment.

P-uptake from different size fractions also showed no notable changes between treatments and experimental days. However, there was a slight effect of nitrogen fixation under warming conditions. Copepod (eggs & Nauplii) production (CP) varied significantly with time during the experiment. Acidification had no clear effect on CP, whereas warming resulted in a significant decline of CP and this decrease was higher than that observed at the warming conditions only.

The overall mesocosm experiment results showed that, for CO2 conditions forecasted for the end of this century, the pelagic ecosystem in the eastern Mediterranean Sea will prove resilient to increases in the ocean acidification. However, the warming will have a more important effect than acidification, and will enhance the effect of acidification on pelagic ecosystem functioning. The results obtained will help to gain insight on the dynamics and trophic efficiency of the Mediterranean plankton ecosystem but may also allow better predictions of the overall effect of ocean acidification and warming on the functioning of marine ecosystems.
Ocean Acidiﬁcation: Global Issue, Local Effects

J. Newton (1); L. Jewett (2); P. Williamson (3); Z. Willis (4); T. Klinger, (5); R. Feely, (6); N. Bednarsek (7)

(1) University of Washington, Applied Physics Laboratory, Seattle, WA, United States of America; (2) NOAA, Washington DC, United States of America; (3) University of East Anglia, School of Environmental Sciences, Norwich, United Kingdom; (4) US IOOS, Washington DC, United States of America; (5) University of Washington, School of marine and environmental affairs, Seattle, United States of America; (6) Paciﬁc Marine Environmental Laboratory, NOAA, Seattle, WA, 98115, United States of America; (7) University of Washington, School of Marine Affairs, Seattle, United States of America

Ocean acidiﬁcation is a global problem already impacting our coasts and oceans at scales that span from individual species to ecosystems to indigenous communities to human industry such as aquaculture. Efforts are underway at several scales to observe ocean acidiﬁcation and its effects on biological organisms. In this talk we present the Global Ocean Acidiﬁcation Observing Network (GOA-ON), as well as how national, regional, and local networks can integrate within GOA-ON. The major characteristics of GOA-ON will be presented, including how this international network is interoperable with observing networks on smaller scales. An example of a composite dataset from the Paciﬁc Northwest United States and observed impacts on shellﬁsh growth and pteropods. Programs from the states of Washington and Oregon and from the United States are being synergized to afford better observing and communication of these data in near real-time. This effort seeks to optimize interoperability and sharing of data. These contributions nest within GOA-ON and help to deﬁne our global status based on the mosaic of local views.

Projected changes, climate change signal, and uncertainties in the CMIP5-based projections of ocean surface wave heights

X. Wang (1); Y. Feng, (1); VR. Swail, (1)

(1) Environment Canada, Climate Research Division, Science and Technology Branch, Toronto, Ontario, Canada

Ocean surface waves can be major hazards in coastal and offshore activities. However, wave observations are available only at limited locations and for a few decades. Also, there exists very limited information on ocean wave behavior in response to climate change, because such information is not simulated in current global climate models.

In a recent study, we used a multivariate regression model with lagged dependent variable to make statistical global projections of changes in signiﬁcant wave height (Hs) using mean sea level pressure (SLP) information from 20 CMIP5 climate models for the twenty-ﬁrst century. The statistical model was calibrated and validated using the ERA-Interim reanalysis of SLP for 1981–2010. The results show Hs increases in the tropics (especially in the eastern tropical Paciﬁc) and in southern hemisphere. Under high-latitude RCP8.5 scenario, the 2099 climate condition of the RCP8.5 scenario, the occurrence frequency of the present-day one-in-10-year extreme wave heights is likely to double or triple in several coastal regions around the world (e.g., the Chilean coast, Gulf of Oman, Gulf of Bengal, Gulf of Mexico).

More recently, we used the analysis of variance approaches to quantify the climate change signal and uncertainty in multi-model ensembles of statistical Hs simulations globally, which are based on the CMIP5 historical, RCP4.5 and RCP8.5 forcing scenario simulations of SLP. In a 4-σ test the extreme wave heights have been found to be signiﬁcant over 16.6%, 55.0% and 57.6%, and the uncertainty (i.e., inter-model variability) is signiﬁcant over 99.9% of the area. The magnitude of the climate change signal is found to strengthen over time, as would be expected. For the historical followed by RCP8.5 scenario, the common signal in annual mean Hs is found to be signiﬁcant over 16.6%, 55.0%, and 82.2% of the area by year 2005, 2050 and 2099, respectively. More recently, we used the analysis of variance approaches to quantify the climate change signal and uncertainty in multi-model ensembles of statistical Hs simulations globally, which are based on the CMIP5 historical, RCP4.5 and RCP8.5 forcing scenario simulations of SLP. In a 4-σ test the extreme wave heights have been found to be significant over 16.6%, 55.0% and 57.6%, and the uncertainty (i.e., inter-model variability) is significant over 99.9% of the area. The magnitude of the climate change signal is found to strengthen over time, as would be expected. For the historical followed by RCP8.5 scenario, the common signal in annual mean Hs is found to be significant over 16.6%, 55.0%, and 82.2% of the area by year 2005, 2050 and 2099, respectively. More recently, we used the analysis of variance approaches to quantify the climate change signal and uncertainty in multi-model ensembles of statistical Hs simulations globally, which are based on the CMIP5 historical, RCP4.5 and RCP8.5 forcing scenario simulations of SLP. In a 4-σ test the extreme wave heights have been found to be significant over 16.6%, 55.0% and 57.6%, and the uncertainty (i.e., inter-model variability) is significant over 99.9% of the area. The magnitude of the climate change signal is found to strengthen over time, as would be expected. For the historical followed by RCP8.5 scenario, the common signal in annual mean Hs is found to be significant over 16.6%, 55.0%, and 82.2% of the area by year 2005, 2050 and 2099, respectively. More recently, we used the analysis of variance approaches to quantify the climate change signal and uncertainty in multi-model ensembles of statistical Hs simulations globally, which are based on the CMIP5 historical, RCP4.5 and RCP8.5 forcing scenario simulations of SLP. In a 4-σ test the extreme wave heights have been found to be significant over 16.6%, 55.0%, and 57.6%, and the uncertainty (i.e., inter-model variability) is significant over 99.9% of the area. The magnitude of the climate change signal is found to strengthen over time, as would be expected. For the historical followed by RCP8.5 scenario, the common signal in annual mean Hs is found to be significant over 16.6%, 55.0%, and 82.2% of the area by year 2005, 2050 and 2099, respectively. More recently, we used the analysis of variance approaches to quantify the climate change signal and uncertainty in multi-model ensembles of statistical Hs simulations globally, which are based on the CMIP5 historical, RCP4.5 and RCP8.5 forcing scenario simulations of SLP. In a 4-σ test the extreme wave heights have been found to be significant over 16.6%, 55.0%, and 57.6%, and the uncertainty (i.e., inter-model variability) is significant over 99.9% of the area. The magnitude of the climate change signal is found to strengthen over time, as would be expected. For the historical followed by RCP8.5 scenario, the common signal in annual mean Hs is found to be significant over 16.6%, 55.0%, and 82.2% of the area by year 2005, 2050 and 2099, respectively. More recently, we used the analysis of variance approaches to quantify the climate change signal and uncertainty in multi-model ensembles of statistical Hs simulations globally, which are based on the CMIP5 historical, RCP4.5 and RCP8.5 forcing scenario simulations of SLP. In a 4-σ test the extreme wave heights have been found to be significant over 16.6%, 55.0%, and 57.6%, and the uncertainty (i.e., inter-model variability) is significant over 99.9% of the area. The magnitude of the climate change signal is found to strengthen over time, as would be expected. For the historical followed by RCP8.5 scenario, the common signal in annual mean Hs is found to be significant over 16.6%, 55.0%, and 82.2% of the area by year 2005, 2050 and 2099, respectively. More recently, we used the analysis of variance approaches to quantify the climate change signal and uncertainty in multi-model ensembles of statistical Hs simulations globally, which are based on the CMIP5 historical, RCP4.5 and RCP8.5 forcing scenario simulations of SLP. In a 4-σ test the extreme wave heights have been found to be significant over 16.6%, 55.0%, and 57.6%, and the uncertainty (i.e., inter-model variability) is significant over 99.9% of the area. The magnitude of the climate change signal is found to strengthen over time, as would be expected. For the historical followed by RCP8.5 scenario, the common signal in annual mean Hs is found to be significant over 16.6%, 55.0%, and 82.2% of the area by year 2005, 2050 and 2099, respectively. More recently, we used the analysis of variance approaches to quantify the climate change signal and uncertainty in multi-model ensembles of statistical Hs simulations globally, which are based on the CMIP5 historical, RCP4.5 and RCP8.5 forcing scenario simulations of SLP. In a 4-σ test the extreme wave heights have been found to be significant over 16.6%, 55.0%, and 57.6%, and the uncertainty (i.e., inter-model variability) is significant over 99.9% of the area. The magnitude of the climate change signal is found to strengthen over time, as would be expected. For the historical followed by RCP8.5 scenario, the common signal in annual mean Hs is found to be significant over 16.6%, 55.0%, and 82.2% of the area by year 2005, 2050 and 2099, respectively. More recently, we used the analysis of variance approaches to quantify the climate change signal and uncertainty in multi-model ensembles of statistical Hs simulations globally, which are based on the CMIP5 historical, RCP4.5 and RCP8.5 forcing scenario simulations of SLP. In a 4-σ test the extreme wave heights have been found to be significant over 16.6%, 55.0%, and 57.6%, and the uncertainty (i.e., inter-model variability) is significant over 99.9% of the area. The magnitude of the climate change signal is found to strengthen over time, as would be expected. For the historical followed by RCP8.5 scenario, the common signal in annual mean Hs is found to be significant over 16.6%, 55.0%, and 82.2% of the area by year 2005, 2050 and 2099, respectively.
Evidence of change in deep-sea ecosystems: a societal concern?

A. Glover (1)
(1) Natural History Museum, Life Sciences Department, London, United Kingdom

Concerns over the potential impacts of recent global change have prompted renewed interest in the long-term ecological monitoring of large ecosystems. The deep sea is the largest ecosystem on earth, with at least the same level of biodiversity, and perhaps the least understood. Nevertheless, deep-sea data collected over the last few decades are now being synthesised with a view to both measuring global change and understanding the processes that further rise in atmospheric carbon dioxide concentrations. For many years, it was assumed by many that the deep sea is a stable habitat, buffered from short-term changes in the atmosphere or upper ocean. However, recent studies suggest that deep-sea ecosystems may respond relatively quickly to seasonal, inter-annual and decadal-scale shifts in upper-ocean variables. At some deep-sea sites, progressive changes can be detected that could be linked to recent climatic change.

Why should society be concerned about changes in the deep sea when it is so apparently remote from most humans economic, social, cultural, aesthetic and ethical world? One answer is that it is one of our last great wilderness regions, filled with an astonishing resolution of undocumented biodiversity. Where it is documented, we have found examples of remarkable evolutionary and ecological novelty that have challenged the notions of where life may exist, or have existed, in elsewhere in the solar system.

Marine cabled observatories as a new technology for the highly integrated environmental and biological monitoring

J. Aguzzi (1); A. Purser (2); L. Thomsen (2); J.B. Company (3)
(1) Instituto de Ciencias del Mar (ICM-CSIC) (www.icm.csic.es), Recursos marinos Renovables, Barcelona, Spain; (2) Jacobs University, Ocean Lab, Earth and Space Sciences, Bremen, Germany; (3) CSIC, Institut de ciències del mar, Barcelona, Spain

Marine depths below 1000 m represent approximately the 65% of the planet surface, making of the deep-sea a stable habitat, buffered from short-term changes in the atmosphere or upper ocean. However, recent studies suggest that deep-sea ecosystems may respond relatively quickly to seasonal, inter-annual and decadal-scale shifts in upper-ocean variables. At some deep-sea sites, progressive changes can be detected that could be linked to recent climatic change.

Habitats characterization of the New Caledonia deep sea ecosystems

J. Delavenne (1); P. Lozouet (2); L. Poncet (3); S. Samadi (1)
(1) museum national d’histoire naturelle, UMR 7174, Paris, France; (2) museum national d’histoire naturelle, UMR 7130, Paris, France; (3) museum national d’histoire naturelle, Service du patrimoine naturel, Paris, France

The impact of climate change on marine ecosystems at different levels is demonstrated by many studies focusing on various regions of the globe. New Caledonia and other south west Pacific islands are very vulnerable to these changes, because of their proximity to the Equator, their relative isolation and limited adaptive capacity. Coral reefs, which are vital resources for the socio-economic and cultural development of many Pacific islands, are threatened by the effects of climate change and the impacts coral reefs. New Caledonia Exclusive Economic Zone is 1.3 million km² and most of it belongs to the deep sea with ridges and seamounts which represent unique ecosystems not easily accessible. It has been shown that deep sea ecosystems can also be impacted by climate change and to evaluate these potential effects the considered ecosystems must be precisely described and characterized.

The exploration program "Tropical Deep Sea Benthos" launches sea surveys in the south west pacific for more than 10 years and 37 sites (38 stations) sampled the New Caledonian waters. This program gathers a worldwide taxonomist network and led to numerous new species descriptions. Here, we used this large taxonomic database to develop a multi-annual multi-taxa approach to describe associations on the New Caledonia seamounts in relation to stable physical environment like depth or slope. Some of the studied species have really narrow distributions or are only known from one location, but these distributions can strongly depend on very local environmental conditions. The change in sea level or sea surface temperature and their consequences on the deep sea habitats could have a strong influence on these organisms.
This study represents a first attempt at the habitats characterization and species associations’ description of the deep sea ecosystems of New Caledonia and will be used to implement conservation and management plans of the area.

P-2208-02

Impact of climatic events on deep-sea ecosystems: the response of cold-water corals to dense water shelf cascades

F. Lartaud (1); E. Peru, (2); N. Le Bris (1)
(1) UPMC, CNRS umr8222, Banyuls-sur-mer, France; (2) CNRS, CNRS umr8222, Banyuls-sur-mer, France

The cold-water scleractinian corals (CWC) are the main ecosystem engineers in the deep-sea, and thus play a key role in deep-ecosystems. They form reef structures that provide niches and nursery grounds for a variety of species, including commercial and/or patrimonial species. Making sense of the significant centers of biodiversity in deep water shelf settings. In submarine canyons, these habitats depend on the exportation of organic matter from the shelf to the deep-sea, and thus are closely related to climatic conditions. Particularly in the Mediterranean Sea, in the Gulf of Lion canyons, which is characterized by seasonal meteorologically-driven hydrological events, resulting from severe coastal storms or from the formation of dense water masses (i.e., cascading). The dense water formation occurs as a result of wind-induced cooling and evaporation of surface waters during winters. This annual pulsed phenomenon last several weeks, with strong inter-annual variation in intensity. The effects of the dense water shelf cascades on cold-water coral reefs are however poorly known. High densities of organic particles associated to the cascading events should constitute an energy supply but the strong currents result in major disturbance in the ecosystem functioning, with breaking of coral fragments.

Therefore, studying the response of cold-water corals to these cascading events is essential (1) to better assess the resilience of present reefs to the environmental dynamics, particularly in Mediterranean where the range and frequency of cascading events will change with the next future with the global warming, and (2) to determine the growth dynamic of fossil reefs, probably linked to past climate conditions.

The development of mark and recapture techniques, coupled with sclerchronological analysis, allows growth rate estimations at the polyp scale based on the identification of staining as a time marker in the skeleton (Lartaud et al., 2013), whereas the use of support cuttings of coral fragments give growth rate information at the colony scale (Lartaud et al., 2014). In situ growth experiment were conducted in the Lacaze-Duthiers canyon (between 340 and 520 m depth) on two reef-building cold-water coral species (Lophelia pertusa and Madrepora oculata). The results show how temporal changes in the growth dynamics, with a seasonal response of M. oculata, whereas L. pertusa appear less sensitive, and inter-annual variability presumably relied to the cascading intensity. Nevertheless, the two species living in the same habitat exhibit distinct growth response both at temporal and spatial scales, which should be take into account for further management strategies in the conservation of these species.

2209 - Transformative pathways to sustain marine ecosystems and their services under climate change

ORAL PRESENTATIONS

K-2209-01

State of the art in oceans and climate change research: Synthesis of the 3rd International Symposium on the Effects of Climate Change on the World’s Oceans (Santos, Brazil; March 2015)

M. Barange (1) ; JL. Valdes (2)
(1) Plymouth Marine Laboratory, Plymouth, United Kingdom; (2) Unesco, Oceanography, Paris, France

There are global concerns over the potential impacts of global environmental change on marine ecosystems and the services they provide. Initial assessments indicate geographically diverse impacts of climate change (Barange et al, 2010), with significant consequences for the wellbeing of dependent communities (Barange et al. 2014). In March 2015, the IOC-ICES-PICES 3rd International Symposium on the Effects of Climate Change on the World’s Oceans was held in Santos (Brazil). This symposium followed the recent IPCC 5th
Assessment Report, which included a number of dedicated ocean chapters. The symposium was a significant event in the challenge to provide evidences and project impacts of climate change on ocean physics and biogeochemistry, ecology, phenology and biodiversity, fisheries and foodwebs, as well as on the use and communication of uncertainties in projection methodologies. In this presentation, the convenors of the IIOC-ICES—PIGES 3rd International Symposium on the Effects of Climate Change on the World’s Oceans, will summarise the main results and highlights of the conference, to update the research and user community on the rapidly developing research field of oceans and climate change.


K-2209-02

Improving climate-resilience in fisheries through rebuilding fish stocks in an uncertain future

W. Cheung (1); T. Froelicher (2); M. Jones, (3); V. Lam, (3); G. Reygondeau (3); J. Sarmiento (4); C. Stock (5); R. Sumaila (1)

(1) University of British Columbia, Fisheries Centre, Vancouver, Canada; (2) ETH Zurich, Zurich, Switzerland; (3) The University of British Columbia, Vancouver, Canada; (4) Princeton University, Aos, Princeton , United States of America; (5) NOAA GFDL, Princeton, United States of America

Seafood is an important source of livelihood, nutrition and culture to many people, in particular, those in coastal communities. The Fifth Assessment Report of Intergovernmental Panel on Climate Change (IPCC AR5) highlights the challenge of sustainable management of fisheries by redistributing fish stocks and therefore catches, particularly with many tropical regions suffering decreases in fisheries production. Overfishing further exacerbates climate risks on fisheries by depleting fish stocks while stock rebuilding is expected to help improve climate-resilience. However, quantitative assessment of the contribution of stock rebuilding in reducing the vulnerability of global marine fisheries to CC, with considerations of projection uncertainties, is not included in IPCC AR5. Using multiple climate–living marine resources models driven by a range of carbon–climate model scenarios, we explore the scope of vulnerability reduction of fisheries under CC and different pathways to stock rebuilding. We show that both CC and fishing scenarios contribute significantly to changes in global fisheries vulnerability through 2050. Overall, stock rebuilding increases climate-resilience of the fishing sectors and marine ecosystems. However, even with stock rebuilding, substantial climate risks, particularly in sensitive ecosystems such as tropical oceans, may not be avoided without substantial reduction in greenhouse gas emission. Our results highlight the need for implementing integrated mitigation–adaptation approaches to improve climate-resilience for the fisheries sectors.

K-2209-03

Challenges and advances in climate projection methodology and their use in projecting oceans futures

Sl. Ito (1); C. Enrique (2); J. Chan Joo (3); W. Muyin (4)

(1) The University of Tokyo, Atmosphere and Ocean Research Institute, Kashiwa, Chiba, Japan; (2) Rutgers University, Department of Marine and Coastal Sciences, New Brunswick, United States of America; (3) Korea Institute of Ocean Science and Technology, Ansan, Republic of Korea; (4) University of Washington, Joint institute for the study of atmosphere and ocean, Seattle, United States of America

Increasing computational power, improved fidelity of climate models and data obtained by global observing networks have advanced our understanding of both climate change and climate model evaluation. In addition, Coupled Model Intercomparison Projects (CMIPs) have contributed to improving climate model ability to reproduce past climates as well as climate variability through the use of ensemble modeling approaches. Nevertheless, typical model resolution is a half to one degree in latitude/longitude scale in the coupled ocean–atmosphere models, which makes it difficult to represent many ocean structures and phenomena important to marine ecosystems (e.g. upwelling, western boundary currents, eddies). Coastal areas are some of the most productive and biodiverse regions, and are dominated by mesoscale phenomena, which cannot be properly resolved by the climate models. One approach that is being used to achieve regional high-resolution climate simulation is the use of nested regional downscaling of a high-resolution limited-area model within a lower resolution large-scale model. Typically, information is downscaled from the coarse- to the fine-resolution region through an overlap in the domain. The finest nest can explicitly resolve features missing from the large-scale model. However, when making a future projection, regional changes may also possibly affect the global climate (i.e. upscaling), and the model requirement is often different when considering ecosystems. For example, phenology is one of the most important items for marine ecosystems; a slight difference in the start of the spring stratification may result in a quite different marine ecosystem response.

Earth system models (ESMs), which include the carbon cycle, couple physics to lower–trophic–level marine ecosystem models. A common major weakness of ESMs lower–trophic–level models is the coarse functional group representation of zooplankton and lack of calibration with zooplankton abundances. This is partly because of the lack of a global database for zooplankton and partly because ESMs lower–trophic–level models have been designed to obtain accurate simulation of marine primary production but not necessarily for zooplankton dynamics. Nevertheless, zooplankton is a key component of marine ecosystems and it is our challenge to improve their representation, as well as the full marine ecosystem in climate models.

K-2209-04

Socio-governance considerations and the impact of climate change on oceans and fisheries

Y. Ota (1); R. Caddell (2); R. Sumaila (1); CM. Andres (1)

(1) University of British Columbia, Fisheries Centre, Vancouver, Canada; (2) University of Utrecht, Department of law, Utrecht, Netherlands

Climate change represents a host of challenges and opportunities for the regulation of fishing effort. Stock displacement due to climate change may increase productivity and improved fishing opportunities in certain locations in a short time, while for other species climate change may truncate their natural ranges and biological processes. Fisheries management bodies will face difficult and often highly politised choices in addressing the future regulation of fishing effort. These developments will clearly have a considerable impact both on fishing economy, society and the legal framework governing fisheries management and allocations. This paper accordingly examines the implications for international ocean governance raised by the impact of climate change on global fisheries, from both a societal and regulatory standpoint.

This paper will first examine the fundamental challenges posed to legal and societal governance of fisheries which change in the context of fisheries, identifying faultlines within the current regulatory regime advanced under the law of the sea that will be most affected by shifts in fish populations. This paper will then move to examine a case-study of how RFMOs and other regulators have responded to population shifts and climate-induced reductions in fish stocks in the emergent regulation of new and exploratory fisheries. To this end, it has been observed that RFMOs exhibit strong potential to regulate new fishing effort in a precautionary manner and in accordance with ecosystem-based management, perhaps in contrast to the way in which many current RFMOs are managed, although the process remains nascent and iterative.

This paper also acknowledges that stock mobility and regime changes could have immediate stresses to those are considered to be vulnerable socially and economically. Accordingly, this paper will examine
Forecasting climate change impacts on tuna populations and fisheries

P. Lehodey (1); J. Senina (1); S. Nicol (2); J. Hampton (2); O. Aumont (3); B. Calmettes (1); A. Conchon (1); M. Dessert (4); AC. Dragon (1); P. Gaspar (1); T. Gorgues (5); M. Lengaigne (6); C. Menkes (7); O. Titaud (1)

(1) Collecte Localisation Satellites, Marine Ecosystem Department, Ramonville Saint Agne, France; (2) Secretariat of Pacific Community, Oceanic Fisheries programme, Noumea, New Caledonia; (3) LOCÉAN, Paris, France; (4) IRD, LPO, Institut universitaire européen de la mer, Plouzané la Trinité, France; (5) IRD, LPO, Brest, France; (6) UPMMC, Paris, France; (7) IRD, LOCÉAN, Noumea, New Caledonia.

The industrial development of High Seas pelagic fisheries targeting associated (tuna) species since the 1950s has taken place in a warming Ocean. The short-living skipjack is the most tropical and productive species while bluefin tuna is the most temperate and long lived, providing small but extremely valuable levels of catch. Rather than a single oceanic habitat, these species have overlapping vertical and horizontal habitats defined by their preferences and tolerances developed over the evolution for several key physical and biological variables. Though some tuna and billfishes can move far in high latitudes searching for rich foraging grounds they all return to warm waters (roughly >24°C) for spawning, leading to seasonal migrations and complex population dynamics mechanisms interacting with several environmental variables. Therefore, characterizing habitats and projecting them in the future using IPCC scenarios is a useful but incomplete approach when investigating the impact of climate change on these species. The progress in the study of climate change impacts on tuna and associated species is reviewed with highlights on recent results based on a Maximum likelihood Estimation approach allowing reconstructing past history of fish population, to dissociate fishing impacts from natural variability, and to forecast population dynamics under climate change scenarios.

Multi-model ocean biogeochemical predictions: an innovative approach

M. Dessert (1); T. Gorgues (1); O. Aumont (2); C. Menkes (3); S. Nicol (4); M. Lengaigne (5); P. Lehodey (6)

(1) IRD/LPO, Institut universitaire européen de la mer, Plouzané la Trinité, France; (2) irD/LOCÉAN, Paris, France; (3) irD/LOCÉAN, Brest, France; (4) IRD, LPO, Institut universitaire européen de la mer, Plouzané la Trinité, France; (5) IRD, LOCÉAN, Nîmes, France; (6) Collecte Localisation Satellites, Marine ecosystem department, Ramonville Saint Agne, France.

Ocean dynamical-biological models are required tools to address consequences of climate change upon marine biogeochemistry and halieutic resources in the future. For the Intergovernmental Panel of Climate Change (IPCC) report, the Coupled Model Intercomparison Project (CMIP5) gathers results of simulations computed from several Coupled Global Climate Models (CGCM, with different physical/biogeochemical Oceanic and/or Atmospheric components). Despite their ability in producing a consistent global warming trend for the future, they are known to display significant biases in the mean state as well as in the variability of the ocean for the historical and present periods along with tremendous regional discrepancies for the future climate variability and marine ecosystems. The discrepancies between the biogeochemical response in these coupled models and the key biogeochemical components used, whose complexity varies from simple nutrient restoring schemes to the explicit representation of several planktonic functional types based on different physiological assumptions. As a consequence, the comparison of the predictions of these different coupled models, crucial to assess how biogeochemistry may vary in the future, has proven to be very challenging. However the tremendous consequences on higher trophic level predicted by models that use future climate scenarios advocate more than ever for a better understanding and quantification of the predictions uncertainties.

To pin point the most robust changes in response to future climates, we propose an innovative method using a single physical/biogeochemical ocean model (PIOMAS/PISCES) forced with a mix of more realistic atmospheric forcing fields (improved ERA-Interim reanalysis) and atmospheric trends extracted from the coupled climate models for the RCP8.5 scenario. With this method, the simulations produce «state-of-the-art» simulations of the dynamic and biogeochemical state of the ocean which span over the historical (1979-2010) and the future (2011-2100) periods using different climates from different climate coupled models but with common ocean/biogeochemical model. The advantage of this method is to constrain the mean patterns of the ocean forcing fields to remain close to the observations, to retain the observed modes of variability while having the changes induced by the anthropogenic perturbations. Using outputs from six CMIP5 coupled models and the produced forcing datasets have been used to force our dynamical/biogeochemical model for the future period.

These forced simulations exhibit spatial pattern of the Sea Surface Temperature (SST) warming similar to the one seen in the corresponding coupled climate models. However, a noticeable difference between the forced and the coupled models can be seen in the equatorial Pacific, and is related to a well known bias of the coupled models (i.e. too weak equatorial upwelling) mostly attenuated with our method. The forced model methods applied and the produced forcing datasets have been used to force our dynamical/biogeochemical model for the future period.

O-2209-01

P-2209-01

Multi-model ocean biogeochemical predictions: an innovative approach

M. Dessert (1); T. Gorgues (1); O. Aumont (2); C. Menkes (3); S. Nicol (4); M. Lengaigne (5); P. Lehodey (6)

(1) IRD/LPO, Institut universitaire européen de la mer, Plouzané la Trinité, France; (2) irD/LOCÉAN, Paris, France; (3) irD/LOCÉAN, Brest, France; (4) IRD, LPO, Institut universitaire européen de la mer, Plouzané la Trinité, France; (5) IRD, LOCÉAN, Nîmes, France; (6) Collecte Localisation Satellites, Marine ecosystem department, Ramonville Saint Agne, France.

Multi-model ocean biogeochemical predictions: an innovative approach

K. Holmsen (1); A. Hollowed (2); K. Aydin, (2); J. Ianelli, (2); A. Punt, (3); A. Hermann, (4)

(1) NOAA Fisheries, Alaska Fisheries Science Center, Seattle, Washington, United States of America; (2) NOAA, Alaska fisheries science centre, Seattle, United States of America; (3) University of Washington, School of aquatic and fishery sciences, Seattle, University of Washington, Joint Institute for the study of the atmosphere and ocean, Seattle, United States of America

Climate change is expected to impact marine ecosystems globally, with larger changes anticipated for Arctic and
sub-arctic ecosystems. We used multi-species stock-assessment models to link climate-driven changes in physical and trophodynamic conditions to recruitment and mortality of three Eastern Bering Sea groundfish species (Gadus chalcogrammus, G. macrocephalus, and Phycis bae黑色, herafter pollock, P. cod, and arrowtooth, respectively) in order to distinguish harvest effects on fish populations from large-scale climate pressures. When we compared model projections under climate sites with realistic historical conditions, we generally found declines in estimated acceptable biological catch (ABC) for pollock and declines in recruitment for both pollock and P. cod. However, projected declines in ABC were sensitive to model specifications of trophic interactions, specifically the strength of bottom-up or top-down controls. Stock assessment models with predation had the largest projected declines, whereas single-species models without bottom-up controls on recruitment had the lowest projected changes in ABC. Inclusion of trophic interactions amplified climate-driven declines or increases in fish abundances, implying that fisheries models that do not include trophic interactions or climate effects might over-estimate sustainable harvest rates for fish species negatively impacted by climate change (e.g., pollock), and under-estimate harvest rates for predator species positively impacted by climate change (e.g., arrowtooth). Our work emphasizes the need to evaluate multiple future scenarios and model structures when projecting climate effects on fisher species.

P-2209-03
Climate Change Affects Marine Fish Distribution: Temporal and Latitudinal Evolution. Approach using GIS Technique and Satellite Data for Data-poor Areas

A. Kaimuddin (1); R. Laë (2); L. Tito De Morais (3)
(1) Institut Universitari Europeu de la Mar (IUEM), Laboratoire des sciences de l’environnement MARin (LEMAR), Plouzané, France; (2) IRD, UMR LEMAR (CNRS/UBO/IRED/IFREMER), IFREMER, Plouzané, France; (3) IRD, UMR LEMAR (CNRS/UBO/IRED/IFREMER), IUEM, Plouzané, France

Accurate knowledge of physical ocean conditions, i.e. sea surface temperature distribution and temporal variation is needed as a key input in many modeling types that are widely used for various applications. Climate varies naturally across time scales and at different latitudes and longitudes. Leading changes reflected by the change in pattern of marine species. Currently, global studies on how temperature changes have been performed in several articles, while studies in smaller region are still few. Besides, collecting the necessary quantitative data on a smaller region is costly. The most powerful way to collect such comprehensive data is through the use of satellite sensors that measure different types of energy coming from the earth. Using 30 years recent version of AVHRR SST dataset Pathfinder 5.2 from NOAA polar-orbiting satellite, we observed changes of objects over time and its effect in marine species distribution in three marine regions defined in LME (Large Marine Ecosystems) and ICES (International Council for the Exploration of the Sea): Canary current, the South European Atlantic Shelf and the Celtic Seas. Species richness in the middle region is generally higher because many species have their southern or northern distribution limits. The zoogeographic importance of this latitudinal area is known as the zoogeographic break between north–eastern Atlantic warm–temperate and cold–temperate regions, which makes the zone an area of great sensitivity to the detection of climate change. The magnitude of change varies between different ecosystems. We modeled the potential distribution of three fish species living in different environments: pelagic (Pomatomus saltatrix), benthopelagic (Balistes capriscus), and demersal (Atheresthes stomias, herather pollock, P. cod, and arrowtooth) species. We were able to demonstrate the potential distribution of marine fish species in space and time and to capture their northern and/or southern limits as well as to follow the evolution of their suitable area from 1981 to 2013. All species showed a northbound trend. This confirms a clear evidence of ocean warming effect in shifting marine fish distribution. The models of species potential distribution were built by projecting the species environmental envelope on the environmental raster time series data. Species environmental envelope or the species realized niche were calculated by estimating the relationship between species records at given sites and the environmental characteristics of the sites. Model projections were compared to the observation. This new approach minimizes the biases from different sampling techniques among data sources as well as issues of small sample data size. When cross- compared with the species’ environmental envelope defined in experimental or observational studies, the result yields coherent results for all species observed. Presentations in the form of animated maps, tables and graphics show the evolution of species’ suitable area over time. This approach can be used to generate environmental envelope for a wide range of organisms as well as their potential distribution in data-poor areas and bring a better understanding of climate change effects in the ecosystems. The model will enhance the prediction models available today and will provide valuable information for conservation planning, fisheries, and climate change studies and furthermore contribute in the conservation study as well as management and conservation strategies.

P-2209-04
Slight impacts of marine animals on ocean biogeochemistry under global climate change

S. Lefort (1); O. Aumont (2); O. Maury, (3); L. Bo¨pp (4)
(1) CNRS, Paris, France; (2) IRD, Paris, France; (3) IRD, Sète, France; (4) CNRS, GIF-sur-Yvette, France

We compared two transient climate change simulations of a global coupled biogeochemical–ecosystem model with and without biological feedbacks in the biogeochemistry. We found that marine animals have little effect on the biogeochemistry of carbon, but they modify the Net Primary Production (NPP) and oceanic oxygen content. These results imply that marine animals take no significant part in the oceanic storage of carbon under climate change. However, as a link of the food chain, they may attenuate the decrease of NPP under climate change through top down effects. On the other hand, as aerobic species, marine animals contribute to decrease the oxygen concentration in the ocean surface and increase the volume of hypoxic/anoxic water in the ocean, reducing their habitats.

P-2209-05
Effect of rising sea surface temperatures on the extension rates of the massive coral Porites spp from the Philippines

M. Manglicmot (1); C. Ringor, (2); F.P. Siringan (3)
(1) UP Institute of Environmental Science and Meteorology and UP Marine Science Institute, University of the Philippines, Quezon City, Philippines; (2) UP Institute of Environmental Science and Meteorology and UP Marine Science Institute, De La Salle University of the Philippines Marine Science Institute, Quezon City, MM, Philippines

The integrity of coastal ecosystems is threatened by the effects of warming ocean waters brought about by global climate change. Thermally-sensitive species such as zooxanthellate corals and the reef structures they form are known to suffer as they operate at optimal temperatures between 25 to 28°C. Long term coral growth band data provide a continuous record of the responses to increasing sea surface temperatures (SST). Extension and calcification rates of massive corals were enhanced at the onset of warming in the twentieth century but recent studies on the Great Barrier Reef, the Red Sea and the Thai–Malay peninsula reported declines with the further increase in SSTs after the 1990s. Other reefs however showed contrasting results with extension and calcification rates higher at present. The variable results of the studies highlight the need to investigate local responses to increasing SSTs. Philippine reefs comprise 8% of the world’s total, following Indonesia
and Australia and is part of the Coral Triangle, described to be centre of marine biodiversity. The impacts of climate change to the country’s reefs cannot be understated. In this study coral growth band data was used to establish the responses of Porites spp from reefs in the Philippines to environmental forcing.

The linear extension rates (LERs) of Porites spp coral cores from the Calaguas Islands (north Philippine Sea), Parola Island, Kalayaan Island Group/ Sabtang (north Philippine Sea), Pamilacan Island (Bohol Sea) and Ayuk and General Islands, Suriago (south Philippine Sea) were measured from the density banding patterns of the coral skeleton revealed through x-radiography. Linear regression and time series analyses were performed to determine the trends. Time series of standardized anomalies of annual LERs of the Porites spp corals from the Philippines all show high interannual variability but the long-term trend displayed a decline in extension rates. The LERs of Porites spp are highly correlated to calcification rates and this decline in extension consequently reflect a decline in the calcification rates of Philippine corals. Different responses at the local level are also evident: the Porites spp from the Calaguas and Suriago reefs declined at different rates. These results even at the local level indicate complex responses of corals to warming ocean waters. Local factors such as wave energy exposure and interannual climate oscillations such as El Niño may enhance or counteract the overall effects of higher SSTs. Nevertheless, an overall decrease in the long-term extension rates of the Porites corals on a national scale (0.038 mm per year) and an increase of mean annual extension of ~0.6°C from 1956 to 2004 was determined and is a cause for alarm as the decline in extension rates and calcification rates of a major reef builder coral, the Porites spp, maybe widespread throughout the Indo-Pacific region.

P-2209-06

Will atmospheric changes impact bioluminescent organisms in the abyss?

S. Martini (1); C. Tamburini (2); S. Escoffier (3); D. Nerini (2)

(1) IRD, perpignan, France; (2) MIO, Marseille, France; (3) IN2P3, Marseille, France

Atmospheric changes are likely to alter the ocean chemistry and potentially affect bioluminescent organisms. A bioluminescent bacteria are capable of emitting light through the chemical process of bioluminescence. In this context, the ANTARES neutrino telescope is a deep-sea cabled observatory situated in the North Atlantic Ocean. The Mediterranean Sea is close to the French coast. An unexpected application is to provide a direct method to detect in situ bioluminescence from deep marine organisms, between 2200m and 2500m depth.

Our two recent studies show that high bioluminescence intensity periods have been detected since 2006 and are related to major water-mass changes due to winter convection. Dense deep water formation occurs during late winter and early spring due to cold, strong and persistent northern winds (Mistral and Tramontane) causing surface cooling. Modified Atlantic Water both on the shelf and over the deep basin. When the cooled shallow waters on the shelf become denser than the ambient waters, they start sinking, overflow the shelf edge, and cascade downslope until they reach their density equilibrium depth, which may vary from 150 m to more than 2000 m. These open-sea conditions represent a major factor in fueling the deep-sea ecosystem with nutrients, carbon, oxygen and potentially organisms. Such water mass changes have been shown to induce higher bioluminescence emission. Indeed, the input of organic matter into the deep water has the potential to fuel the deep-sea biological activity. Bioluminescent bacteria are potential contributors to high bioluminescent events affected by environmental growth conditions.

P-2209-07

National ocean modeling for Philippine coral reef connectivity

MM. Noblezada (1); C. Villanoy, (1); D. Manalaysay (1); KM. Yatco (1); PL. Cadelina (1); P. Pata (1); C. Benjamin (1); A. Yniguez (1)

(1) Marine Science Institute, University of the Philippines, Diliman, Quezon City, Philippines

The Philippines being an island nation of 7,100 islands, has one of the longest (34,000 km) coastline in the world characterized by highly complex bathymetry and hydrography. The country’s reef system is extensive (25,000 km2) and its rich marine life is world acknowledged. Coral reefs are critically important ecosystems, as they provide valuable services including resources for coastal communities, buffer vulnerable coastlines from storm surges and habitat to various marine organisms. However, the country’s coral reef system is in a degraded status attributed to various anthropogenic activities such as overfishing and unsustainable exploitation, sedimentation, and more recently events related to climate change such as extreme storms and coral bleaching which have led to declines in the function and resilience of these important ecosystem. Furthermore, Philippines are among the ten most vulnerable nations in the world affected by the impacts of climate change such as sea-level rise and severely damaging typhoons. Key capabilities such as numerical and biophysical modeling and their visual outputs are valuable due to their capacity to provide a broad overview of connectivity patterns by tracking population sources and sinks as well as predictions of past and future hydrodynamic events. There is a growing evidence and efforts acknowledging connectivity and tracking population sources and sinks play an integral role in the understanding of reef populations to survive disturbances particularly related to climatic change such as typhoons, bleaching events, crown-of-thorns predation and diseases, any of which may increase and severity with changes in climate. This information as well can assist in the identification and monitoring of important or vulnerable habitats and designing management and conservation strategies. Here we present and describe the application of these approaches in determining pattern of reef connectivity in the Philippines. Philippine scale HYCOM model nested to the global HYCOM model runs for both real-time and hind cast mode and particle tracking model driven by the HYCOM hydrodynamic model to estimate coral reef connectivity patterns and matrices will be implemented. Model output will be offered for access near real-time via an OpenDap server to be setup for disseminating model results. Ongoing model simulations and preliminary results are presented.

P-2209-08

The High-latitude Coral reefs of South Africa: A Canary in the Coral Coal Mine?

M. Schleyer (1)

(1) Oceanographic Research Institute, PO Box 10712, Durban, South Africa

Coral reefs are amongst the ecosystems most vulnerable to climate change. They occur at high-latitude in South Africa where they are at the southernmost limit of their
Projecting the state of the Mediterranean Sea Ecosystem under contemporary and future climate

C. Solidoro (1); P. Lazzari, (1); G. Galli, (1); MC. Donata (1); G. Cossarini, (1); T. Lovato, (2); M. Vichi, (3); C. Martin, (4); M. Giannoula, (5); M. Scard, (6)

(1) Istituto nazionale di Oceanografia e di Geofisica Sperimentale OGS, oceanography, Trieste, Italy; (2) centro mediterraneo cambiamenti climatici, bologna, Italy; (3) university of cape town, cape town, South Africa; (4) united nation environmental program world conservation, Marine assessment and decision support, cambridge, United Kingdom; (5) hellenic centre for marine research, irklkon, Greece; (6) universita tor vergata, roma, Italy

A suite of validated three-dimensional physical-biogeochemical-ecological models is used to assess the impact of future climatic and management scenarios on biological and ecological properties of the Mediterranean Sea. Results are discussed in term of temporal and spatial distributions of variables and indicators related to physical fields, carbonate system, cycles of carbon and inorganic nutrients, potential changes in higher trophic level organisms dynamics and in the distributions of critical habitats such as Posidonia oceanica and coralligenous formations.

Towards a coastal vulnerability typology for small islands: Assessing diversity and similarity via a common framework

R. Mclean (1)

(1) University of New South Wales, School of physical, environmental and mathematical sciences, Canberra, BC ACT, Australia

The Small Islands chapter of the IPCC AR5 reaffirmed the vulnerability of small islands to climate change threats due to their inherent physical and human characteristics, high exposure to extreme events, vulnerability of island communities and economies on threatened ecosystems such as coral reefs and mangrove forests. It also emphasized that small islands present diverse risk profiles – a point that has not been sufficiently recognized in the literature. The chapter invited the scientific community to include island diversity in future V & A assessments within a consistent methodology appropriate at regional, archipelagic and island scales.

Envisaged was the design of a new island typology reflecting both the heterogeneity and homogeneity of islands and island coasts that also included a range of climate–ocean processes and not just sea-level rise.

Economic valuation and ecological status of coralligenous habitats under climate change

L. Thierry De Ville D’avray (1); JF. Féral, (1); D. Ami, (2); A. Chenuill, (1); R. David (3)

(1) IMBE, Marseille, France; (2) GreQAM, Marseille, France; (3) CNRS, IMBE, MARSEILLE, France

Climate change first impacts are on ocean temperature, acidification, nutrient content. In this context marine ecosystems may evolve in a «no return state». How will be this state? Study are on progress on marine living beings, but many incertitude remains.

Coralligenous habitats are typical Mediterranean marine coastal habitats identified on most Mediterranean coast at depth between 20 and 120 m. These biogenic hard bottoms, mainly formed by calcareous rhodophytes develop in conditions of reduced light, and at temperature of 13-20°C. With about 1670 species recorded, they are among the most important sources of marine biodiversity in the Mediterranean with Posidonia meadows (UNEP, 2007). This rich biodiversity and ecological functions inherent to the ecosystem are the source of a set of ecosystem services or «biological processes which man can benefit» (Boutron, 2009). Their use or their perception by human gives amenities that can lead to an economic valuation. Current knowledge on coralligenous allows to affirm their contribution to (i) the production of food resources and raw materials, (ii) the regulation of coastal ecosystems, and (iii) the realization of recreation diving and fishing thanks to their attractive landscape and abundance of «gourmet» species.

Are the “right” to access to this ressource around Mediterranean sea equal? What are the different factors that influence the repartition of valuable species, for food security and for “ecotourism”? The study will demonstrate that ecosystem services from coralligenous habitats economic value of some of these services are impacted by climate change. The impact in quantity and quality of services, may affect the access to different services, and thus their value.
Over the past three decades many coastal vulnerability assessments have been undertaken in the Caribbean, Mediterranean, Indian and Pacific Oceans most of which have applied a predetermined methodology with an emphasis on sectors, e.g., water, human health and agriculture on certain coastal types, e.g., deltas, mangrove shores and sandy beaches, and with an almost singular focus on sea-level rise. None of the assessments have: (1) covered whole regions; (2) dealt with the full range of coastal and island types; and (3) considered the entire suite of climate-change drivers.

A probabilistic approach to a vulnerability assessment that meets these criteria has been developed in the Pacific covering 15 countries and 1532 islands. The objective was to produce a regional coastal vulnerability typology based on the inherent geomorphological characteristics of islands and on the relative contributions that driving forces make to change. Development of the typology comprised a series of nested scales with increasing spatial and temporal resolution. Each step involved an analysis of a coastal segment of a single island. Initially, islands were classified into 8 types based on two simple characteristics: lithology (rock type) and maximum elevation. To these attributes were added island area and shape to develop an ‘indicative susceptibility’ index. This index recognized that certain island types are inherently more susceptible (less resistant) to change than others, for example a low elevation sand beach island is more susceptible than a high elevation volcanic rock island. A five-point susceptibility rating was derived for all 1532 islands that included all island types within each country in the region, e.g. the 431 islands in the Solomon Islands.

The second step was to refine the scale from whole-island to coastal-margin with more variables added to the diagnostic criteria. For this reason, the analysis of islands such as Caucau Peninsula and Manzanillo are presented because of their coastal vulnerability. We developed a coastal vulnerability typology for each island type that can be used to invest in targeted and transferable adaptation projects with island partners; and (3) be applicable at all scales from global to local including other small island regions.

K-2210-02

Benefits of mitigation of climate change for coastal areas

R. Nicholls (1)
(1) Tyndall Centre for Climate Change Research, Southport, United Kingdom

This presentation will review the possible benefits of mitigation of climate change for coastal areas with a strong emphasis on sea-level rise. This is one of the most certain consequences of human-induced global warming and has significant impacts. Importantly, there is a long-term ‘commitment to sea-level rise’ due to the long thermal lags of the ocean system and hence the response of sea-level rise to mitigation is slower than for other climate factors. Therefore, while climate change mitigation reduces coastal impacts during the 21st century, compared to unmitigated emissions, the largest benefits may occur in the 22nd century (and beyond). While we cannot avoid some rise in sea level, it can still avoid significant losses of the Greenland and Antarctic ice sheets, with significant long-term benefits to coastal inhabitants. The available results suggest that a mixture of adaptation and mitigation policies need to be considered for coastal areas, as this will provide a more robust response to the full range of climate change drivers. Therefore, while the policy in isolation. This point has been clearly articulated in coastal impact chapters of the Fourth and Fifth IPCC Assessments. This approach requires the joint evaluation of adaptation and mitigation in coastal areas which has not been systematically considered to date. Because of the long time constants involved such assessments need to continue beyond 2100 to provide the full implications of the different policy choices. While the basic scientific commitment was available and presented in the First IPCC Assessment, the policy implications are less appreciated and need wider discussion.

K-2210-03

Marine and Coastal Ecosystems: what are the impacts?

LM. Piedra Castro (1)
(1) Universidad Nacional, Escuela de Ciencias Biológicas, Cartago, Costa Rica

Coastal areas have traditionally been important to the development of human communities. Those who have exploited ecosystemic resources they provide them. These systems have been overexploited and polluted modified by human activities. Changes in the coastal and marine systems are occurring due to climate change. Therefore, while the basic science of the impact of climate change may be impacting these ecosystems. The objective of this study was to analyze the factors affecting coastal and marine ecosystems and their conservation. For this analysis, the Coast of the Caribbean coast of Costa Rica, including the southern sector. The evaluation was conducted in the communities of Westfalia, Vizcaya, Cahuita, Puerto Viejo, Manzanillo and norths winds, affecting upper parts of the beach that could be affected by sea-level rise. The objective was to provide insights into the changes that are occurring in the Caribbean coastal environments and the potential implications for coastal ecosystems.

Climate change impacts on coastal ecosystems have been assessed in several studies. These studies have shown that climate change can lead to changes in the distribution of species and changes in the productivity of ecosystems. The study of the response of coastal ecosystems to climate change can be achieved through the use of models and remote sensing techniques. These tools have been used to assess the changes that have occurred in the coastal ecosystems of the Caribbean coast of Costa Rica. The assessment of the changes in the coastal ecosystems has been achieved through the use of models and remote sensing techniques. The changes that have occurred in the coastal ecosystems have been assessed through the use of models and remote sensing techniques.

The analysis of the changes in the coastal ecosystems of the Caribbean coast of Costa Rica has been achieved through the use of models and remote sensing techniques. The changes that have occurred in the coastal ecosystems of the Caribbean coast of Costa Rica have been assessed through the use of models and remote sensing techniques.
recruitment of larvae and the effect may start slowly or potentially be mitigated by the resilience of whose mechanisms of macroevolution system could not hope to provide answers to climate change. The strategies by reduce pressures on the species referred must be reduced the pressure in this ecosystem. In that sense, they must have the flexibility to confront climate change and that seems to be the most recommended practice in marine and coastal areas due to the direct consequences of influence on the way that it is known about forecast that various forms of disruption in islands and low-lying coastal states due to storm surges, flooding and sea level rise can be expected, with high confidence. Specifically, the AR5 emphasizes the risk of loss and damage to vital living and non-living resources, including important coastal areas (e.g. beaches, coral reefs, seagrasses, mangrove wetlands) and their associated goods and services. While impact severity will vary within and among regions, the AR6-SPM WGII projects that some small island states could suffer damages and adaptation costs of ‘several percentage points of GDP’ over the 21st Century and beyond.

By virtue of the ‘openness’ of their economies and the consequential reliance on imports and exports to sustain livelihoods, small islands are heavily dependent on the functionality and efficiency of their air and sea ports. Unlike many larger continental-scale countries, international trade in SIDS is not facilitated by other transportation media such as road and rail. Between fifty and ninety percent of all food and beverages consumed in SIDS come from external sources, and more than ninety percent of all energy products used in SIDS, including hydrocarbon fuels, are handled through air and sea ports. On average, in excess of half of the country’s export and import revenues from all sectors pass through these ports of entry. In addition, SIDS earn considerable local and foreign revenues from various port-related activities, including berthing, bunkering, airport landing and maintenance, containerized and other storage charges, waste reception fees and cruise passenger imposts, inter alia. As in other countries, considerable direct and indirect employment is also generated by air and sea ports in SIDS.

The climate-related risks posed to ports must therefore be carefully considered by the countries and coastal states. While an increasing number of vulnerability assessments conducted on islands have evaluated the impacts of climate change and climate variability on coastal and marine ecosystems, few have specifically examined the implications of the threat for ports in these regions. Hence, this work attempts to contribute to filling that gap by focusing on the vulnerability of air and sea ports in SIDS to climate change-related impacts. More specifically, the risks posed to port infrastructure by sea level rise and projected changes in the behavior of some hydro-meteorological events will be examined. Equally, the potential for disruption to critical port-related functions as a consequence of climate change, will also be explored.

Some guidance on the selection of criteria for evaluating the appropriateness of adaptation responses is offered, which is hoped would be helpful to port managers and planners in the SIDS regions. In this regard, while the similarities among small islands will help to form a basis for identification of some criteria, the guidance emphasizes that island diversity in its many forms – biogeophysical, economic, socio-cultural and political – helps to shape the risk profile of each country, and should therefore be an important consideration in adaptation choices, including in the air and sea port sub-sector.

Finally, it is cautioned that notwithstanding the uncertainties, delaying adaptation in this crucial sub-sector, the lynchpin of many island economies, may not be prudent, given the conclusions of the IPCC-AR5. It is suggested that an approach to adaptation which judiciously integrates what is known about the present-day vulnerability of ports with our ‘best understanding’ of future climate risks, would constitute a meaningful risk management strategy for air and sea ports in SIDS.

O-2210-01
Assessing the vulnerability of Air and Sea Ports in Small Islands: Risk Factors and Adaptation Guidance
L. Nurse (1)
(1) University of the West Indies, CERMES, Faculty of Science and Technology, Bridgetown, Barbados
Since publication of the IPCC First Assessment in 1990, all subsequent reports have identified key reasons for and drawn global attention to, the vulnerability of small islands to the adverse consequences of climate change, particularly sea level rise. The recently released Working Group II Contribution to the Fifth Assessment Report (AR5-SPM-WGII), notes that climate-related impacts affect coastal states due to storm surges, flooding and sea level rise, with high confidence. Specifically, the AR5 emphasizes the risk of loss and damage to vital living and non-living resources, including important coastal areas (e.g. beaches, coral reefs, seagrasses, mangrove wetlands) and their associated goods and services. While impact severity will vary within and among regions, the AR6-SPM WGII projects that some small island states could suffer damages and adaptation costs of ‘several percentage points of GDP’ over the 21st Century and beyond.

By virtue of the ‘openness’ of their economies and the consequential reliance on imports and exports to sustain livelihoods, small islands are heavily dependent on the functionality and efficiency of their air and sea ports. Unlike many larger continental-scale countries, international trade in SIDS is not facilitated by other transportation media such as road and rail. Between fifty and ninety percent of all food and beverages consumed in SIDS come from external sources, and more than ninety percent of all energy products used in SIDS, including hydrocarbon fuels, are handled through air and sea ports. On average, in excess of half of the country’s export and import revenues from all sectors pass through these ports of entry. In addition, SIDS earn considerable local and foreign revenues from various port-related activities, including berthing, bunkering, airport landing and maintenance, containerized and other storage charges, waste reception fees and cruise passenger imposts, inter alia. As in other countries, considerable direct and indirect employment is also generated by air and sea ports in SIDS.

The climate-related risks posed to ports must therefore be carefully considered by the countries and coastal states. While an increasing number of vulnerability assessments conducted on islands have evaluated the impacts of climate change and climate variability on coastal and marine ecosystems, few have specifically examined the implications of the threat for ports in these regions. Hence, this work attempts to contribute to filling that gap by focusing on the vulnerability of air and sea ports in SIDS to climate change-related impacts. More specifically, the risks posed to port infrastructure by sea level rise and projected changes in the behavior of some hydro-meteorological events will be examined. Equally, the potential for disruption to critical port-related functions as a consequence of climate change, will also be explored.

Some guidance on the selection of criteria for evaluating the appropriateness of adaptation responses is offered, which is hoped would be helpful to port managers and planners in the SIDS regions. In this regard, while the similarities among small islands will help to form a basis for identification of some criteria, the guidance emphasizes that island diversity in its many forms – biogeophysical, economic, socio-cultural and political – helps to shape the risk profile of each country, and should therefore be an important consideration in adaptation choices, including in the air and sea port sub-sector.

Finally, it is cautioned that notwithstanding the uncertainties, delaying adaptation in this crucial sub-sector, the lynchpin of many island economies, may not be prudent, given the conclusions of the IPCC-AR5. It is suggested that an approach to adaptation which judiciously integrates what is known about the present-day vulnerability of ports with our ‘best understanding’ of future climate risks, would constitute a meaningful risk management strategy for air and sea ports in SIDS.

O-2210-02
Managing increasing risks in coastal cities
S. Hallegatte (1) ; R. Nicholls (2) ; J. Corfee-Morlot (3) ; C. Green (4)
(1) Climate Change Group , Washington , United States of America; (2) Tyndall Centre for Climate Change Research, Southampton, United Kingdom; (3) OECD, Paris, France; (4) None, London, United Kingdom
Coastal areas are particularly exposed to climate change and sea level rise, and large coastal cities represent hotspots of vulnerability and risk. In particular, coastal protections calibrated for current hazards and environmental conditions can quickly become inappropriate given rapid changes in sea level: with rapid climate and economic trends, good protections can be more dangerous than helpful, in the absence of continuous adaptation. This presentation illustrates on how for coastal cities, coastal protection could be expected to reach a sea level with and without adaptation, and discusses policy implications regarding coastal protection, risk management, and investment needs. A specific focus will be given to the need for comprehensive risk management packages that combine ex ante prevention actions with ex post actions that enhance the ability of the affected cities and people to recover and reconstruct. Finally, implications on poverty and inequality will be discussed, as protection choices will have large distribution and wealth impacts.

O-2210-03
Coastal forested wetlands as affected by sea-level rise and land-use in Caribbean islands: lessons from the past
D. Imbert (1) ; D. Galop (2) ; A. Lenoble (3) ; C. Stouvenot (4)
(1) Climate Change Group , Washington , United States of America; (2) Tyndall Centre for Climate Change Research, Southampton, United Kingdom; (3) OECD, Paris, France; (4) None, London, United Kingdom
Coastal forested wetlands as affected by sea-level rise and land-use in Caribbean islands: lessons from the past
D. Imbert (1) ; D. Galop (2) ; A. Lenoble (3) ; C. Stouvenot (4)
(1) Climate Change Group , Washington , United States of America; (2) Tyndall Centre for Climate Change Research, Southampton, United Kingdom; (3) OECD, Paris, France; (4) None, London, United Kingdom

Tropical coastal plains and estuaries have developed large forested wetlands during the present postglacial transgression. In the Caribbean islands, such wetlands are subjected to specific hydrological characteristics due to small tidal range, seasonal rainfall, minimal silatation, and frequent powerful hurricanes. In this context, a large amount of the atmospheric carbon fixed annually by the vegetation is stored underwater and form peat deposits several meters deep. As a result, these autochthonous organic sediments act as invaluable paleoecological archives of past climatic changes and catastrophic events that have affected coastal ecosystems over times. Recent and ongoing research conducted in the Lesser Antilles is presented to document this issue and put into a broader perspective the expected changes for the near future. In Guadeloupe, peat sediments over 10 meters depth have accumulated at an average rate of 1 mm/year during the last 3000 years, with no significant variation of the coastline. However, recent data indicate that before 4000 years B.P. faster sea-level rise (≥ 1.5 mm/year) may have cause dramatic coastline retreat. In the meantime, periodic climatic changes (drier/wetter) have caused functional and structural changes whereas human activities inside these wetlands contributed to reduced forested areas (especially swamp forests) and, comparatively, promote herbaceous vegetation. Current trends in sea-level rise indicate that compensatory threshold of soil-level rise is being exceeded; as a result, landward intrusion of saltwater wedge is expected to occur farther and more frequently, especially under a forecasted dryer climate. Conversely, endangered freshwater ecosystems like the Pterocarpus swamp forest could be at risk of extinction because of the limited possibilities of upward migration, due to land use and inland steep topography.
Short- and long-term impacts on coastal power plants under sea level rise

R. Bierkandt (1); M. Auffhammer (2); A. Levermann (1); B. Marzeion, (3)
(1) Potsdam Institute for Climate Impact Research, Research domain sustainable solutions, Potsdam, Germany; (2) University of California, Berkeley, United States of America; (3) University of Innsbruck, Institute for geophysics and meteorology, Innsbruck, Austria

Unmitigated greenhouse gas emissions may increase global mean sea-level by up to 1m during this century. Such elevation of the mean sea-level enhances the risk of flooding of coastal areas. Assuming, that existing power plants are protected against a 100-year flood risk, we compute the additional risk of flooding by the end of the century for different US states, if no adaptation measures are taken. The additionally exposed capacity varies strongly between states. For Delaware it is 80% of the currently generated power. For New York this number becomes 63% and for Florida 43%. The capacity that needs additional protection compared to today’s status increases by more than 250% for Texas, 90% for Florida and 70% for New York. Current development in power plant building points towards a reduced future exposure to sea-level rise. Currently operating power plants are less exposed than those who have been retired or canceled and currently planned plants will be less exposed than those operating at present. If sea-level rise is properly accounted for in future planning, an adaptation to sea-level rise appears to be possible.

A complete melting of the Antarctic ice-sheets leads to a long-term sea-level rise by up to 65 meters over a time period of several thousand years depending on the amount of carbon emissions within the next decades to centuries. Decommissioned nuclear reactors that will be dismantled will be less exposed than those who have been retired or canceled and currently planned plants will be less exposed than those operating at present. If sea-level rise is properly accounted for in future planning, an adaptation to sea-level rise appears to be possible.

Islets of New-Caledonia lagoons in the perspective of Climate change and sea level rise

M. Garcin (1); M. Vendé-Leclerc (2); B. Robineau (2); P. Maurizot (2); G. Le Cozannet (3); A. Nicolae-Lerma (1)
(1) BRGM, DRP/R3C, Orléans, France; (2) DIMENC, Sqnc, Nouméa, New Caledonia; (3) BRGM / CNRS, BRGM–DRP–R3C / CNRS–LGP (UMR–8591), Orléans, France

Context and problematic: On July 7th 2008, UNESCO included parts of Lagoons of New Caledonia in the list of the Reef Diversity and Associated Ecosystems. Sandy islets from New Caledonian lagoons lie on lagoonal reef platforms or on the reef barrier. They have a major role in these specific and rich ecosystems, being the seat of nesting for turtles, seabirds, sea kraits etc. In addition, islets have a high importance in terms of their social and cultural way of life; economy of the islands has been developed around tourism and services with specific activities such as sports and relaxation. One of the recurrent issues for people and governmental agencies concerns the islets’ future in the perspective of Climate Change and Sea Level Rise. In this context, the Coastal Observatory of New Caledonia (OBlic) has initiated research about the recent and present evolution of islets in order to predict their “behavior”.

Method: Around twenty islets from the southwestern and eastern lagoons of Grande-Terre (New Caledonia main island) and one from Nokanhui atoll (Ile des Pins) have been studied. Such studies integrate field work and observations (erosion scars, accretion and sedimentological data) and analysis of historical photographs and satellites images. Geomorphological and sedimentological data have been collected during 2013 and 2014 field surveys. Past extensions of each islet have been interpreted using available aerial views and satellite sensing. Old aerial photographs are rather rare because islets being sometimes quite away from the shore, they were not covered by aerial survey of the main island. All available data have been used to reconstruct the islet’s reconstitution extends from one decade to 70 years. Time evolutions of shape and surface of each islet have been mapped in order to compute surface changes and the present percentage of coast’s lengths in erosion, accretion or stable. Moreover, the forcing factors such as winds, wave, tropical storms or cyclone, and the ENSO have been analyzed in order to understand potential links with the islet behavior.

Results: In terms of size and shape, a high diversity and a variety of evolution trends of islets during the past decades can be noticed. Actually, processes affecting the coast of each islet (erosion, accretion, stability) are highly variable. All islets have at least 50% of their coasts affected by erosion and for four this rate is close to 100%. Fluctuations of the reef Diversity and associated ecosystems. Sandy islets showing increasing surface during the past years are very rare. Analysis and observations show that five main stages constitute the life-cycle of Caledonian islets, namely: nucleation, growing, maturity, decay, relic or null. Changes of environmental parameters and forcing factors as well as the inherited geomorphology lead the islets from one stage to another. The becoming of each islet is linked to its past evolution, its present state and future evolution of environmental parameters. Parameters are linked to the climate variability like ENSO or IPO which control the intensity and direction of trade winds and the average sea level in the SW Pacific. Forcing factors include also extreme events like cyclones, storms and austral swells which can trigger at very short term powerful erosion or accretion with high impact on the islets. Sea level rise induced by the anthropogenic climate change has also to be taken into account. Using our data and informations and postulating that the current situation remains identical, we consider that : 19% of the islets are in a critical state with a very likely disappearance in the next future (few years); 10% of the islets are in a critical situation with a likely disappearance in the next future.
and very likely disappearance in the middle term (next decades). These events show a rapid evolution which can lead to their disappearance in the middle term but not in the next future; 10% of the islets are not endangered at short and middle time scale and 43% of the islets are not endangered at all scales (due to eroding, large surface, relatively high altitude). Our results show that situations are contrasted from one islet to another. We have also to emphasize that uncertainties are higher for middle and long-term future due to many uncertainties about the sea level. Uncertainties are also linked to the potential reaching of a thresholds value (value and rates) which would lead to a modification of the resilience capacity of each islet. Thus, a coastal is likely to be of first importance, monitoring the impact of climate change and sea level rise on such systems.

P-2210-04

Sea-level rise impact on European shelf tide dynamics

D. Idier (1) ; F. Paris (1) ; G. Le Cozannet (2) ; F. Boulahya (1) ;
(1) BRGM, Orléans, France; (2) CNRS-DRRM-DYN/DRP-R3C / CNRS-LGP (UMR-8591), Orleans, France

Sea-level rise (SLR) affects not only the total water level, but also the tidal dynamics. Several studies have investigated the SLR effect on the tide of the Western European continental shelf, analysing the tidal dynamics (mainly the M2 component) for various SLR scenarios or coastal defence schemes. The present study aims at completing existing knowledge, using a modelling based approach, investigating 11 tidal component scenarios from 0 to +10 m SLR, analysing the effect on high/low tide water level as well as the amplitude and phase tidal components. Sea-level rise scenarios include the present sea-level, as well as several idealized scenarios that correspond to plausible sea-levels for more or less distant past or future. On the one hand, the -0.25m scenario can be considered as a low bound for the preindustrial sea-level. On the other hand, the +10 m SLR scenarios correspond to more or less plausible sea-levels in the future: according to IPCC, a rise of sea-level of +25cm is likely by 2046–2065 whereas higher SLR scenarios are not excluded by 2100, sea-level will continue to rise beyond 2100, and it is likely to reach values of several meters by 2200 and beyond. Finally, the +10 m SLR scenario corresponds to a situation where most Greenland and west–Antarctic ice-sheets have melted.

Assuming that coastal defences along the present day shoreline are maintained and upgraded, the patterns of increase / decrease of high tide level (annual maximum water level) are almost stationary in most of the area (70%), which increases in most of the domain and a decrease mainly in the Western English Channel. These changes are globally varying linearly with the SLR, till the +2m SLR scenario, with rate ranging between -15% and +15% of SLR. The main patterns are: (1) a decrease in the Western English Channel, (2) an increase in the Irish Sea, Southern North Sea and German Bight. The analysis of tidal component contributions shows that high tide level changes patterns are not exactly similar to M2 pattern changes (e.g. along the French Atlantic coast, high tide level increases whereas M2 amplitude decreases). This highlights the need to take into account all the components when analysing SLR effect on tides. Main changes in the maximum water level result from the changes of the M2, S2, N2, M4 and M54 components. Sea-level rise pushes several areas (e.g. Atlantic coast, Irish Sea) closer to resonance, leading to the decrease in tidal components (especially semi-diurnal or quart-diurnal, depending on the area).

The linear behaviour of tide dynamics with the SLR is highly sensitive to the coastal defence strategy (i.e. jet flood or not), the high tide level varying much less linearly with SLR when flooding is allowed, like for instance in the German Bight. However, several areas appear not sensitive to this choice, such that the estimated trends there are highly probable: an increase of ~6% SLR (resp. decrease of ~15% SLR) in the North of Irish Sea (resp. in the Western English Channel).

Finally, preliminary investigations show that, at least, for the non-uniform SLR scenario we computed, the high water level is very weakly sensitive to the (non)-uniformity, local rates of increase/decrease (relative to local SLR) being similar to the ones obtained from uniform SLR scenarios.

P-2210-05

Vulnerability of Coastal Crop Land to Climate Change in the Northern Part of Bay of Bengal: Issues, Challenges and Future Prospects

AHM. Kamal (1) ; MH. Nesarul (2)
(1) Universiti Putra Malaysia Bintulu Sarawak Campus, Animal Science and Fishery, Bintulu, Sarawak, Malaysia; (2) University of Chittagong, Institute of marine sciences and fisheries, Chittagong, Bangladesh

The coastal communities of northeastern part of Bay of Bengal are used to live and survive through facing different types of natural disasters since primitive time. Among the natural disasters, salinity intrusion due to climate change and sea level rise in the coastal agriculture land is the major unpleasant incident now days. Because of that wide area of the coastal agricultural land, coastal forest, drinking water facilities and fresh water availability are in critical condition which may cause 40 million people of 147 coastal districts covering 47201 km area are placed in danger. The nation wide assessment on the detected of coastal soil and water salinity is not conducted since 9 years. The survey on the coastal soil salinity on 1973 and 2000 found that the saline effected land is increased from 0.83 million ha to 1.20 million ha within 27 years. It is estimated that at present the extent the rate of salinity increase in the coastal agriculture land will be higher than those of 1973 and 2000. The soil salinity was recorded 18-20 ppt after AILA in the south-eastern coast of Bangladesh and increased further due to the saline water intrusion which causes crop burning. This paper aims to show the salinity intrusion in the coastal soil and water of Bangladesh, which would help to plan and improvement of the sustainable agriculture production. Study revealed that to face any extra stresses on the coastal agriculture land due to climate change requires extensive inventory, awareness activities, mitigation measures, adaptation techniques and extension of indigenous technology.

P-2210-06

Impact of climate change on estuarine ecogeomorphology, and application to the Loire estuary

P. le Hir (1) ; R. Walther (2) ; F. Cayocca (1) ; J. Sawtschuk (3) ; F. Biotre (3) ; P. Bona (4)
(1) IFREMER, Dynamiques de l’Environnement Côtiér (ODE/ DYNECO), Plouzané, France; (2) Plouzané; (3) Université de Bretagne Occidentale, Institut de géoarchitecture, Brest, France; (4) GIP Loire Estuaire, Nantes, France

Besides temperature increase, the main expressions of climate change in estuarine environments are sea level rise and possible change in storm regimes downstream, variations of river flow and solid fluxes upstream. For instance, in northern Europe, lengthening of the low river discharge duration is often predicted, leading to salinity intrusion and upwards shift of turbidity maximum in estuaries, with possible effects on water quality. Previous modelling work on the Loire and the Seine estuaries (France) suggested that sea level rise (SLR) would only reduce the tidal amplitude. Whereas the present work has demonstrated that some estuaries (France) suggested that sea level rise (SLR) would only reduce the tidal amplitude. Whereas the present work has demonstrated that some estuaries
questions. A first one accounts for morphological coupling and the delayed sedimentation process. The study aims at classifying the estuarine systems response to climate change according to various types of hydrodynamic forcing (tide amplitude, river flow), bed sediment, wind and sediment transport, and morphological configurations. The model is fully process-based, with a sediment module that accounts for sand and mud behaviour. Long term simulations (typically 100–200 years) are achieved thanks to the use of a morphological factor.

A second model is a similar process-based model with muddy mobile sediment, applied to the Loire estuary. The computation grid is refined in intertidal areas, allowing accurate simulation of specific hydrodynamics in a realistic complex network of creeks and vegetated areas. This model is used to predict deposition on lateral marshes, and its validation according to the location of the turbidity maximum which is related to the river flow. The model has been validated against field measurements, in terms of suspended sediment concentration and sedimentation rate. Tests on schematic geometries show that (1) SLR increases the tidal oscillating volume and consequently the hydraulic energy within the estuary, which results in channel widening or the development of creeks in elevated marshes; and (2) a strong dependence on the upstream sediment input: high sediment fluxes increase the sedimentation on the intertidal flats, while these flats are likely to be eroded in case of sediment deficit.

In cases of reasonable sediment input, a 1 cm/year SLR is never compensated by sedimentation, and flooding rate increases as well. In these cases, lateral sedimentation is likely to continue, inducing a following reduction in the inundation rate. All these features are strongly dependent on the initial configuration, in particular the cross profile of the alluvial plain which allows or not any lateral extension of the flood. Surprisingly, vegetation on marshes does not seem to impact these processes much.

Simulations on the Loire estuary were run for the coming 30 years, and based on a 34cm SLR and longer low river regime duration, as predicted by hydrological regional models (project ICC Hydroqual). Results show that the turbidity maximum would slightly increase (despite a reduction of upstream sediment input) and would shift 5 km upstream, like salinity intrusion. Only a small fraction (5–10%) of the mobile sediment stock would support lateral sedimentation not enough to compensate SLR. Based on recent observations and comparison with 30 years old data, the potential effect on vegetation was assessed: upstream shift of halophytes and development of halophytes on marshes.

Urban Landscape Remodeling for Climate Resilient Neighborhoods in Coastal Mega-cities of India Using Integral Geographic Information System: A Participatory Urban Climate Change Risk Reduction Framework for Greater Mumbai Metropolitan

A. Tiwari (1)
(1) National Institute Of Technology, NITB, India

Indian coastal metropolitans represent the most densely populated and highly congested urban areas and rank among some of the largest urban settlements of the planet in terms of population. However, these mega-cities are characterized by inadequate infrastructure, lack of civic amenities and constraints of access undermining carrying capacity and resilience of urban ecosystems. Climate change has resulted in increased frequency, severity and intensity of extreme weather events, particularly high intensity rainfall, floods and cyclone. Moreover, long-term impact of climate change is expected to result in uncertainty pertaining to energy consumption, and thereby reducing efficiency of urban energy systems and resilience to adaptation further. Furthermore, temperature extremes are likely to adversely affect the accessibility to green and open spaces, and community services, particularly water, sanitation, health, public transport, markets and community centers posing serious threat to live–ability and resilient lifestyles. These changes are offsetting the interconnected network of urban infrastructure and services in sprawling coastal cities. Study aims at developing a participatory climate resilient urban neighborhoods through urban–surface ‘remodeling’ approach in ‘Integral Geographic Information System’ (GIS) environment for coastal megacities with the illustration of Mumbai.

The paper uses terrain analysis tools in integral geographical information system platform to identify and map the climate susceptible urban fabric and check the scope for urban landscape remodeling without adding to its (often) complex fragmentation. Harmonizing with people’s perception and adaptation knowledge, and incorporating options and priorities of city administration and other stakeholders, the urban surface remodeling through integral GIS ensures inclusive solutions with reduced vulnerability and increased efficiency. The application of integral GIS resolves conflicting perspectives, interests, and approaches of the multiplicity of stakeholders involved at various levels in climate smart urban planning. It ensures barrier-free decision making for decision making while looking for long term feasible outcome of remodeled surfaces. Surfaces available for remodeling include paved ground, streetscapes, commercial facades, rooftops, green areas,oster areas as well as right procedures to follow. These tools should assess, estimate and project scenarios of coastal evolution in a manner–term and short term. To prioritize the projections, as many variables as possible should be analyzed, and the impact of each of these variables on the shoreline evolution should be understood. The study has been used to evaluate and identify the SH lateral changes during the past 15 years in Kalpitiya peninsula. Both Remote Sensing and Image processing techniques were used to extract Shoreline. Shoreline vector data method was used in Digital Shoreline Analysis System (DSAS) of ArcGIS10.1 to estimate the change in shoreline (positive or negative). R 2.14.0 was used to calculate relationship between time and sand deposition/erosion in Kalpitiya Peninsula. In this ongoing study, temporally changing shoreline changes of Kalpitiya peninsula to be investigated on ArcGIS 10.1 with DSAS tool. It was found out maximum and minimum Shoreline Change rate as well as Shoreline erosion/deposition rate. The study defines the time and Shoreline change distance was recorded positive relationship such as 0.97, at the confidence level of 0.05. These results shows North Western part coastal area in Sri Lanka. The study defines the relationship of risk areas in Kalpitiya coast, considering the uncertainty associated with erosion and wave climate sequences. The study help to identify and prepare different risk maps according to clay climate sequences. Results further obtained, defining areas of high, medium and low risk of shoreline loss due to erosion.
Control of mangrove abundance by decadal changes in oceanic wave fields

R. Walker (1)

(1) Université Paul Sabatier – CNRS, Umr S245 ecolab, Toulouse, France

The ocean surface is crossed by fields of wind-generated waves. These can travel over basin–wide distances and drive a large portion of coastal sediment transport when they reach continent margins. The variability of wave fields is thus of crucial importance to understand observed natural changes of coastal areas such as tidal wetlands. However, we have to date, no model capable of predicting wave fields at regional scale and over the course of several decades. Here, we provide a 64-year analysis of coastal changes on the open–coast mangrove shoreline situated downdrift of the mouth of the Amazon River. We show that over 1950–2014, changes in North tropical Atlantic wave heights have primarily affected sediment dynamics leading to important natural variations observed in mangrove surface areas. We show that model results respond to low frequency fluctuations of wave fields mainly associated with the decadal variability of the wintertime North Atlantic Oscillation. Our results emphasize the need for a better understanding and quantification of the role of climate variability on coastal dynamics. This can be crucial in anticipating the near future evolution of tidal wetlands and their carbon stock in the context of anthropogenically climate change.

2211 - Climate change in mountains: from impacts to resilience

ORAL PRESENTATIONS

K-2211-01

Impacts on society and economy of a changing climate and climate-generated hazards on mountain water resources

M. Beniston (1); C. Tucker (2); G. Grandjean (3)

(1) University of Geneva, Institute for Environmental Sciences, CAROUGE / GENEVA, Switzerland; (2) Indiana University, Anthropology, Bloomington, IN, United States of America; (3) BRGM, Risk and Prevention, Orleans, France

Mountains represent significant features covering nearly one-quarter of the world’s terrestrial surface. Mountains support a range of socioeconomic sectors (e.g., tourism, forest production, ecosystem resources) that have experienced considerable change in the last two centuries, resulting from pressures on natural resources and traditions imposed by increasingly-industrialized societies. Development trajectories of these high-value environments vary considerably across the globe, both within and between mountain areas. These have been extensively transformed, converting them from inaccessible and relatively poor hinterlands into attractive destinations for the wealthy, sometimes excluding long-time inhabitants from economic benefits. In certain cases, outmigration and an aging population have led to economic declines in agro-pastoral and forestry production. Across the world, such transformative processes in mountain social–ecological systems have been accompanied by profound social, institutional, and environmental changes. As a major supplier of resources, mountains collectively represent in particular the source region for more than 60% of surface waters. A significant fraction of world’s population in lowland regions depends on mountain water resources for agriculture, industry, energy, and domestic water supply.

Rapid climate change occurring in mountains carries broad implications, given that such regions have long been a source of valued ecosystem services and natural resources. For example, future shifts in temperature and precipitation patterns, and changes in the behavior of snow and ice in many mountains may ultimately change the quantity, seasonality, and possibly also the quality of water originating in mountains and uplands. Natural processes controlled by hydro-meteorological triggers (e.g., floods, landslides, debris-flows, earthflows and rockfalls, glacier melt, river erosion) will in a future climate add further environmental pressures on both social and natural systems, thereby highlighting the need to promptly conduct proactive adaptation plans.

The challenge for both mountain societies and those located downstream but dependent on mountain water resources in particular is thus to estimate as accurately as possible future changes in water availability. This will help to prepare the way for appropriate adaptation strategies and improved water governance. Enhanced awareness and appropriate policies aimed at alleviating the more adverse climate impacts would help indigenous populations to better adapt to rapid change, and for water–dependent economic sectors to pursue their activities with lower risks of economic rivalries or conflicts.

O-2211-01

Challenges and Possibilities for Sustainability in Mountain Social-Ecological Systems: Results from a Global Analysis

J. Klein (1); A. Nolin (2); C. Tucker (3); K. Hopping, (1) ; A. Grêt-Regamey (4); S. Lavaudel (5); B. Müller (6); F. Bourgeron, (7); V. Bucit (8); E. Castellanos (9)

(1) Colorado State University, Fort Collins, United States of America; (2) Oregon State University, College of Earth, Ocean, and Atmospheric Sciences, Corvallis, OR, United States of America; (3) Indiana University, Anthropology, Bloomington, IN, United States of America; (4) ETH, Zurich, Switzerland; (5) CNRS, Laboratoire d’Ecologie Alpine, Grenoble, France; (6) Helmholtz–Zentrum für Umweltforschung GmbH – UFZ, Leipzig, Germany; (7) University of Colorado, Boulder, United States of America; (8) University of California, Berkeley, United States of America; (9) Universidad del Valle de Guatemala, Centro de Estudios Ambientales y de Biodiversidad, Guatemala, Guatemala

Mountain regions provide critical hydrological and diverse ecosystem services to over half the planet’s human population, most of whom live in the lowlands. At the same time, mountain systems face mounting pressures from climate change and policy actions at local, national, and global levels. Using mountain case studies from around the world, we describe the suite of characteristics and incongruities that create particular challenges for mountain sustainability, and also present a conceptual model of mountain social–ecological systems (MSES) that highlights the broad processes driving mountain system dynamics and their ecosystem services from local to global scales. We focus our analyses across all of the mountain system’s scales, between vegetation and non–subsistence based mountain regions, and among land use groups that are dominated by tourism, pastoralism and crop agriculture. We then explore the use of coupled models explaining social behavior, policy and management, and economics with models simulating biophysical processes as a potential tool for identifying sustainable trajectories in mountains, particularly when used within an interdisciplinary framework. We analyze an analysis of existing coupled social–ecological models in mountains and examine how these models are currently employed to address critical mountain sustainability issues.

Our analyses reveal patterns in mountain characteristics, livelihood strategies and associated challenges for sustainability. Mountains are geographically and culturally complex systems that deliver ecosystem services from local to global scales and are prone to hazards and extreme events. Particularly among the subsistence–based sites, mountains continue to be physically remote and distant from centers of power and decision–making. These
features, combined with high representation of indigenous peoples and cultures, result in social, economic, and political isolation and marginalization. Stemming from the dynamic and non-linear interactions of the mountain characteristics are mountain-specific problems that are qualitatively different, often lacking clear definitions and optimal solutions, so-called "wicked problems" which we identify as incoherencies. The most ubiquitous incoherence across all of our mountain case studies is that of "politics and the environment" systems and a phenomenon that results in perverse policies and present barriers to climate change coping mechanisms and adaptations.

Climate change, extreme weather events, markets, policy, and land use change are key drivers across all case study sites, while phenomena such as land tenure change, resource extraction or mountain land change are more important within subsistence-based mountain sites. We explore the primary scales at which these drivers occur and how they interact with mountain land use and livelihood groups, and with the delivery of mountain ecosystem services across scales.

Based on our analysis of social-ecological modeling studies in mountains, we suggest that a coupled model involving multiple levels of participation, such as local resource users and policymakers, could be a powerful tool for understanding the interrelatedness of mountain and decision-makers about future trajectories of MtsES. We also conclude that while modeling efforts are currently focused on system understanding and prediction, there is great potential to also employ models that foster social learning and communication.

We conclude by identifying knowledge gaps and challenges regarding future sustainability. For a next step, we propose to use transdisciplinary modeling approaches in mountains, including co-creation of knowledge, participatory approaches, and coordinated practices, all of which are essential for sound decision-making and building resilient futures.

O-2211-02

Facing climate change in the Peruvian Andes: implications of shifts in precipitation patterns, river discharge and the availability of water resources for local communities and options for adaptation

N. Andres (1) ; P. Calanca (2) ; N. Salzmann (3) ; V. Bustindia (4) ; C. Huggel (5) ; M. Rohrer (6) ; R. Neukom (5)

(1) Swiss Federal Institute for Forest, Snow and Landscape Research WSL, Mountain Hydrology and Mass Movements, Birmensdorf, Switzerland; (2) Agroscope, Institute for Sustainability Sciences (ISS), Department of natural resources and agriculture, Zürich, Switzerland; (3) University of Fribourg, Department of Geosciences, Fribourg, Switzerland; (4) Programa de Adaptación al Cambio Climático–PACC, MINAM–COSUDE–Helvetas Swiss Intercorperation, Cusco, Peru; (5) University of Zürich, Department of geography, Zürich, Switzerland; (6) Meteorat GmbH, Zürich, Switzerland

Communities in the high Andes are considered among the most vulnerable to climate change for various reasons. For example, erosion control is largely practiced at a subsistence level and exposed to droughts, frosts, late season warm spells, pests and diseases. Also human settlements are often endangered by landslides which are only one of the cause of damages to buildings and infrastructure but also responsible for numerous casualties in the recent past. In view of a possible decrease in seasonal precipitation amounts but a more frequent occurrence of intense rainfall events, this situation is likely to worsen in the future as a consequence of climate change. This calls for cross- and interdisciplinary programmes that can help improving the resilience of Andean communities.

In response to this call, the Peruvian Ministry of the Environment has collaboration with the Swiss Agency for Development and Cooperation (SDC) under the Global Programme Change Climate (GPCC), initiated in 2009 the "Programa de Adaptación al Cambio Climático en el Perú" (PACC), a programme that is now in its second phase. Involving practitioners and scientists from various disciplines, the specific goal is to build awareness, improve preparedness, and support and promote the process of adaptation. Its implementation includes the scientific assessment of climate impacts, vulnerabilities and risks, and the practical evaluation of adaptation options. This can be considered as a minimum framework to move from impacts to resilience.

With a focus on the implications of seasonal shifts in the precipitation regime for water availability and river discharge, in this contribution we present a few examples that demonstrate the involvement of our work in the latest implementation process. We first report on a modelling study of the impacts of climate change on the water resources in the Vilcanota river basin. The results indicate an increase in river runoff during the rainy season, but an overall decrease in water storage. The former is expected to lead to higher flood peaks, whereas the latter is expected to entail water shortage, in particular during the dry season. This is of concern because communities have already to face loss of glacier ice in the Cordillera Vilcanota, a process that is already changing the seasonality of water availability.

The second example is drawn from studies aiming at assessing the potential impacts of changes in temperature and precipitation on rainfed annual crops in the Central Andes of Peru. While in the near future not all crops would suffer from the projected decrease in water availability, it is shown that adaptation of the agricultural practices is necessary in the mid and long term to sustain production and improve food security of the local population. Suggested adaptation measures include the adjustment of cropping calendars, the introduction of more robust crop varieties and alternative cropping systems and reconsideration of land use.

The third example shows how the rediscovery of groundwater, traditional technologies can contribute to improve the resilience of rural communities facing a decreasing availability of water resources. Specifically, we report on the outcomes of an effort to promote rustic micro-reservoirs called qochas. These were already used in ancient Peru, but had largely fallen in disuse until recently. As a test, about 150 qochas were built between 2012 and 2013 in two small watersheds of the Peruvian Altiplano with the help of farmers and their families. Benefits from their establishment have included the recovery of downstream springs, the recovery of vegetation in the surroundings of the reservoirs and an overall easier access to water during the dry season.

O-2211-03

Impact analysis of Climate Change on Glacier and Water Potentiality in High Altitude Region of Western Himalaya

BW. Pandey (1)

(1) University of Delhi, Department of Geography, Delhi, India

Present research aims to investigate the issues concerning ecohydrology and potentiality of water in high mountain areas of Western Himalaya. Hindukush–Himalaya (HKH) region are the source of perennial rivers of South and East Asia which feed almost half of the world population. For the climate, people, economy and ecology, Hindukush–Himalaya region are known as "Human Equator" as drinking water for humans and animals; water for irrigation of food and other crops; and, more importantly, water for hydroelectric use: hydropower depend on water of the HKH Mountains. Increasing populations and economic transformations have exerted considerable pressure on land and water resources in Western Himalaya. Such changes have brought modifications in water flows, nutrients, sediments and pollutants as well as loss of biodiversity. Hence, the ecohydrological processes in headwater regions of western Himalaya, especially the role of natural processes, the impact of human interference and climate change on the availability of water, highland–lowland interactive linkages, and sustainable use of water require attention for planning and preservation. The present paper aims to contribute to a better understanding of the vulnerability of the land–water system to human activities and climate change impacts in high mountain region of Western Himalaya.
O-2211-04

Past and future changes in seasonal snow in the French Alps: implications for water resources, mountain tourism and avalanche hazard

S. Morin (1); M. Déqué (2); H. Castexbruget (3); Y. Durand, (1); N. Eckert (4); H. Francois (5); E. George-Marcelpii (5); G. Giraud (1); B. Hingray (6); M. Lafayesse (1); E. Martin (7); M. Roussset (1); Verfaillie (1); (1) Meteo–France – CNRS, CNRM–GAME/CEN, St Martin d’Heres, France; (2) Meteo–France – CNRS, Cnrm–game, Toulouse, France; (3) INSA Lyon, Lgcie–deep, Villeurbanne, France; (4) Irstea, Etna, Grenoble, France; (5) Irstea, Dtm, Grenoble, France; (6) Crgn, Grenoble, France; (7) Metéo France, Cnrm–game, Toulouse, France.

Snow on the ground is a key environmental and socio-economic component of mountain regions. Storage of water in the form of snow during the winter period provides freshwater input to ecosystems, agriculture and human consumption. Natural hazards such as snow avalanches and snowmelt floods cause loss of lives and disruption of human activities. Snow plays a pivotal role for numerous socio-economic activities such as hydropower (electricity generation and industry) and winter tourism.

The French Alps have encountered significant changes of snow conditions over the past decades, which can be inferred from the improved meteorological analysis system SAFRAN feeding the detailed snowpack model Crocus. Superimposed over a large year–to–year variability, these changes are most pronounced in mid–altitude areas which are highly sensitive to the rain/snow partitioning of precipitation. Such an extensive reanalysis of meteorological and snow conditions has been further used to un–bias and downscale regional climate model projections spanning the XXIst century. The presentation will highlight key results at the scale of the entire French Alps obtained using CMIP3 projections and preliminary results using CMIP5/ECORECDEX projections.

The interpretation of the numerical simulations spanning the observational era for the past decades and an ensemble of climate projections into the XXIst century not only addresses changes of snow conditions in terms of snow water equivalent, relevant for water resources, but also trends in the seasonality of discharge in selected catchments, avalanche hazard and resort–level snow viability. The latter is currently being developed accounting not only for meteorological drivers of snow on the ground but also socio–economic components of mountain regions (i.e. managing snow management practices and the spatial organization of ski resorts. This approach seeks at contributing to an integrated representation of the impact of climate change in mountain areas thereby helping to assess the resilience of these sensitive environmental and socio-economic systems.

O-2211-05

Challenges and needs for interdisciplinary studies on mountain water resources: current issues and perspectives

JP. Dedieu (1); I. Zin (2); T. Condron (3); JE. Sicard (3); Y. Arnaud (3); A. Rabatel (4); D. Six (4); C. Obled (5); (1) CNRS, LTHY, Grenoble, France; (2) CNRGS, LGCIE, Grenoble, France; (3) IRD, LTHY, Grenoble, France; (4) UJF, Lgge, Grenoble, France; (5) LTHY, Grenoble, France.

Hydro–meteorological observations coupled with snow and ice measurements are the basic material for a number of scientific and operational issues linked to socio–environmental needs. They are required for studies aiming at understanding the climate–environment–society interactions along with their spatial and temporal variations. They constitute also the basic information for estimating hydrological resources and risks, real time operation of catchments, monitoring of environmental impacts, etc. The aim is to foresee adaptations strategies required by societies to face changes in resource and risks induced by ongoing global change. In mountainous areas, such observations are even more pronounced and variable than anywhere else, as hydro–meteorological events are more pronounced and variable than anywhere else. Major difficulties due to topographic constraints as elevation and slopes, added to strong local weather conditions, reduce the capabilities of long–term observation networks in regard of lowlands observing systems.

Supported by the Laboratory of Hydrology and Environment (LTHE) and the Laboratory of Glaciology and Environmental Geophysics (LUGE), Grenoble (France), we focus here on some “Hot–Spot” application areas which federate cross–disciplinary approaches (i.e. mountain climatology, hydrology, glaciology, natural hazards versus socio– ecological systems), linked to national Programs (ANR, local stakeholders) and long term Observatory Programs (e.g. GlacierL, Creaglacier, Gaia). The efforts of this collaboration will be presented. The XXIst century is highlighted by various key hydrological issues, taken from the operational research or environmental monitoring domains. Measurement networks and observatories developed will meet the corresponding objectives are presented. Limits of observations, associated to the measurements themselves, spatial representativeness and temporal coverage are discussed. Some perspectives for improving current observations systems are finally suggested.

2211–POSTER PRESENTATIONS

P-2211-01

Society adaptation for coping with mountain risks in the climate change context

S. Bernardie (1); G. Grandjean (2); N. Desramaut (1); M. Gremont (3); JP. Malet (4); A. Puissant (4); T. Houet (5); JM. Antoine (5); F. Bourlier (6); M. Fort (7); D. Pierre (8); (1) BRGM, Risk and prevention, Orleans, France; (2) BRGM, Risk and Prevention, Orleans, France; (3) BRGM, Montpellier, France; (4) UNistra, Strasbourg, France; (5) GEODE, Toulouse, France; (6) IRSTEA, Grenoble, France; (7) PRODIG, Paris, France; (8) Geo–Hyd, Orleans, France.

Mountains represent an important part of the global earth system. Because of their vertical extent, climate varies drastically with elevation and thus differs from those in adjacent lowland areas. Natural processes controlled by hydro–meteorological triggers (e.g. floods, landslides, rockfalls) will add further environmental pressures on both social and natural systems, stressing the need to promptly conduct proactive adaptation plans. The relevance of mountain hazard and risk zonation for environmental policy and decision making is set forth in the European Thematic Strategy for Soil Protection and the associated proposal of a Framework Directive, in which hydro– meteorological hazards are considered as one of the socio–threats for which it is necessary to identify risk areas where risk reduction measures have to be implemented. However, to implement risk mitigation strategies in an integrated way (e.g. including physical but also economic and social adaptation), additional research is needed on how climate controls mountain hazards occurrence. The influence of climate and climate change on slope stability and floods over various spatial and temporal scales has to be better understood and quantified; studies are also needed on how the main economic, social and political stakeholders interact for the definition of adaptation scenarios at the regional scale.

The SAMCO (Society Adaptation for coping with Mountain risks in a global change Context) project aims to develop a proactive resilience framework to characterize and measure the resilience of societies on the impacts of mountain risks. The project aims to elaborate methodological tools to characterize and measure ecosystem and societal resilience from an operative perspective on three mountain representative case studies.

To achieve this objective, the methodology is split in several points with (1) the definition of the potential impacts of global environmental changes (climate system, ecosystem e.g. land use, socio–economic system) on landslide hazards, (2) the assessment of these sequences in terms of vulnerability (e.g. changes in the location and characteristics of the impacted areas and level of their perturbation) and (3) the implementation of a methodology for quantitatively investigating and mapping indicators of mountain slope vulnerability exposed to several hazard...
types, and the development of a GIS–based demonstration platform.

The strength and originality of the SAMCO project is to combine different techniques, methodologies and models (dynamical, statistical, statistical–economic, risk evolution in time, vulnerability functional analysis, and governance strategies) and to gather various interdisciplinary competences in earth sciences, environmental sciences, and social sciences.

The climate change inputs of the project correspond to at least 2 scenarios of greenhouse gas emissions (RCP: Representative concentration pathways, according to the standards defined by the GIEC): RCP 2.8, RCP 4.5 and RCP 8.5 for the ALADIN–Climate model of Météo–France, and RCP 4.5 and RCP 8.5 for the WRF model used by the IPSL. The impact of climate change is then firstly addressed through the use of these climate scenarios into hazards computations. In that way, future changes in temperature and precipitation volume and patterns are analyzed, permitting to address the direct and indirect impacts of climatic change on mountain societies and their vulnerability to change.

Secondly, the climate change is also considered in global scenarios, with taking into account political actions at local and global scale that might influence the climate change as well as the land use planning in the areas of interest. It is then possible to identify the most important factors of community's resilience (e.g. coping capacity) and their dependence upon controlling factors in order to propose risk management strategies adapted to possible impacts of global changes.

Hazard Assessment of Glacial Lake Outburst Flood and Potential of ICTs for Coping: A Case of Eastern Himalaya of Nepal

DR. Bhattarai (1)
(1) Tribhuvan University, Central Department of Environmental Science, Kathmandu, Nepal

Retreat of glaciers and formation of glacial lakes in Nepal Himalaya have been reported to be related with the temperature rise in the region. Glacier Lake Outburst Floods (GLOF) are the growing climate induced hazards in the Himalaya. GLOF has increased the vulnerability of communities and ecosystems to extreme events. This study has analyzed the potential impacts from GLOF in the highland of eastern Nepal and the potential role of Information Communication Technologies (ICT) to cope with the possible hazard caused by the occurrence of GLOF. This work was carried out by preparing the latest location map of the glacial lakes using google earth and ArcGIS applications in the highland of the Kanchanjungha Conservation Area of the region. Tippta Glacial lake, located at an elevation of 4950 m, within the Kanchanjungha Conservation Area, was selected for the GLOF hazard assessment. I used semi–structured questionnaire survey and key informants' interviews in the community in order to assess the potential hazard of GLOF. With the varying sizes of 46 glacial lakes were located in the region, which covers over 2.57 sq. km in total. Though the larger portion of the downstream area of the Tippta glacial lake fall in the remote location away from major residential area, few villages, major pasture lands for Yaks, foot trails, and several bridges across the Tamor River below the lake are in risk of GLOF. Poor access due to geographical remoteness and limited capacities to afford the modern technologies in the community are the major limiting factor to the knowledge and information about the climate change and related impacts. Modern ICTs has high potential to reduce the risk of climate related hazards in the remote area by information dissemination and awareness.
P-2211-04

Projected changes on the surface water resources of the Rhenhaya basin (High Atlas, Morocco) by a set of Med-CORDEX models

L. Hanich (1) ; Y. Tramblay (2) ; A. Marchane (3) ; J. Jarlan (4) ; D. Ruelland (2)
(1) Faculté des Sciences et Techniques/Université Cadi Ayyad, Sciences de la Terre, Marrakech, Morocco; (2) IRD – HydroSciences Montpellier, Montpellier, France; (3) Faculté des Sciences et Techniques/Université Cadi Ayyad, Sciences de la Terre, Marrakech, Morocco; (4) IRD – Centre d’Études Spatiales de la Biosphère, Toulouse, France

To anticipate the potential changes in water quantity available within the Rhenhaya mountainous watershed (near to Marrakech), it’s important to know the evolution of this resource in relation with climate changes. In this study we use the GR4J model with a snow module with time series of precipitations and discharge (1987-2009). The model was calibrated and validated successfully over various periods. Then we used an ensemble of 5 regional climate models (RCM) provided by the Med-CORDEX program with a method of perturbation by quantiles to simulate future scenarios of flow predictions.

The evaluation of the precipitations simulated by the RCMs models (RCM) shows a strong underestimation of ~50% but a good reproduction of the cycle for the temperatures. The future changes according to two scenarios RCP4.5 and RCP8.5 shows a rise of the temperatures (~1.4°, +2°) in relation with a decrease in total precipitation (~19%, -31%). Concerning the hydrological modeling with GR4J, stable results are obtained for calibration and validation whatever the chosen period, with maximum bias of 15% in validation on the monthly flows. Flow forecasts (2049–2065) present a strong projected decrease in surface runoff (~30%, ~60%) and significant drops of the snow-covered reservoir levels, related to the precipitation decrease and the temperature increase.

P-2211-05

Debris flow in the French Alps in changing climate

V. Jomelli (1) ; N. Eckert (2) ; I. Pavlova (3) ; D. Brunstein (4)
(1) CNRS, Physical geography, Meudon, France; (2) Irstea, Etna, Grenoble, France; (3) Unesco, Paris, France; (4) CNRS, Geography, Meudon, France

In the Alps, debris flows are a major threat as they periodically damage infrastructure, may even cause loss of life. The triggering process is definitely sensitive to climate change due to an interaction between meteorological and geomorphological factors, such as extreme precipitation, the local topography or the accumulation of rock debris. Evaluating the link between climate and debris flow activity is the necessary pre-request to estimate the impacts of future climate change.

Here we analyze the evolution of debris flow occurrence in the French Alps over the last four decades using an innovative probabilistic model which makes it possible to analyze the main environmental and climatic drivers of debris flow occurrence simultaneously, so as to quantify their respective influence at a regional scale.

As a case study, we extract 124 debris flow events triggered between 1970 and 2005 in 27 catchments located in the French Alps from the French national natural hazard survey and model their variability of occurrence considering environmental and climatic predictors at the same time. We document the environmental characteristics of each debris flow catchment (morphometry, lithology, land cover, and the presence of permafrost). We also compute 15 climate variables including mean temperature and precipitation. For October and the number of rainy days with daily cumulative rainfall greater than 10/15/20/25/30/40 mm day−1. Application of our model shows that the combination of environmental and climatic predictors explained 77% of the overall variability of debris flow occurrences in this data set. We also note that the occurrence probabilities depend mainly on climatic variables, which mostly explain the variability through the number of rainy days and maximum daily temperature. This important time component in the variability of debris flow occurrence is shown to be responsible for a significant increase in debris flow activity between 1970 and 2005 at regional scale. Environmental variables, which accounts for 1/3 of the overall variability, includes mostly the morphometric variables of the debris flow catchments.

P-2211-06

Diurnal cycle processes associated with precipitation in central Andes (Peru)

C. Junquas (1) ; K. Takahashi (2) ; S. Chavez Jara (2) ; T. Condom (3) ; J. C. Espinoza (2)
(1) Instituto geofisico del Peru, Lima, Peru; (2) Instituto geofisico del Peru, Lima, France; (3) IRD, L’Hévé, Grenoble, France

The identification of regional atmospheric processes is important to understand how the greenhouse gases increase in the atmosphere could affect the precipitation and the water resources at a regional scale.

The atmospheric processes in the tropical Andes climate are of particular interest because in this region, mechanisms are associated with the interplay of complex orography and convective processes characterizing the tropical climate. In the Andes, precipitation processes are associated with the humidity transport between the wet Amazon on the east and the dry Pacific on the west, and the spatio-temporal distribution of the precipitation are little understood.

The Andes cordillera is extended over almost all South America, that are 7000km between 45°S and 7°N, its maximum width is 1800km in its central part. This configuration is unique in the planet, and consequently the glaciers in the tropical Andes represent 99% of the world tropical glaciers. These glaciers show a retreat since the 1970s with an unprecedented acceleration since 70’s. The risks generated by such glacier retreat are here in terms of hydrological resources, agriculture, hydro-electricity, and tourism. Tropical glaciers mass balance is strongly depending of humidity and precipitation, so it is important to study localized associated atmospheric processes. The identification of high-resolution horizontal scale climate mechanisms (some km) in terms of diurnal cycle could particularly help to understand how the atmospheric circulation influence the glaciers mass balance at diurnal time-scales. The characterization of humidity fluxes and of the associated spatial distribution of the precipitation in central Andes, with in addition the understanding of localized atmospheric processes in terms of diurnal cycle variability are the main objectives of this study.

Due to a poor number of in-situ meteorological stations in the region of the central Andes, we consider that a dynamical downscaling using a regional climate model is the most adequate methodology to improve the understanding of localized orographic processes in this region. The WRF (Weather Research and Forecasting) model is used to simulate the climatological diurnal cycle of the wet season (austral summer) in the Cuzco region (central Andes), at a 9-km horizontal resolution and 3-hourly time resolution. The precipitation model outputs are compared with radar products of TRMM–2A25 and in situ observations. Results show that it is possible to reproduce the main diurnal precipitation features with rainfall maximum in the western cordillera during the afternoon, and in the eastern part of the cordillera during the night. The model results show the influence of orographic processes with the formation of cold pools. In summary using a dynamical downscaling with the WRF model is able to reproduce the main diurnal precipitation features. This difference seems to be linked with the width and the orientation of the different valleys.

P-2211-07

The Himalayan Cryosphere and Highlanders’ Adaptability: A Case Study of the Miyar Valley of Himachal Pradesh and North Sikkim in the Indian Himalaya

U. Lal (1)
(1) Sikkim University, Geography, Gangtok, Sikkim, India
P-2211-09

Creation of modern approach adaptation of water consuming branches to climate changes and degradation of glaciers
P. Normanov (1)
(1) Tajik National University, Meteorology and Climatology, Dushanbe, Tajikistan
One is actual problems of modernity is Global Climate Change and adequate behavior of the each component of ecosystems to this change. For the Tajikistan 93% territory, which do mountains and which characterized by availability more 8500 glaciers by the total area of 8.6-6.6 km² occupy, or about 6% of all area of the Republic of Tajikistan is very important. There is a large unit of conglomeration in mountains of Northwest Pamir with the center of Fedchenko glacier – the largest mountain glacier in the world. By 1988, the glacier has receded more than on 500 m and has decreased on the area for four square kilometers. Average speed of step of Fedchenko glacier for the last century made 10–12 meters one year. Average speed of movement of glacier in connection with loss of weight has decreased with 72 up to 69 sm daily. In total for 20th century the glacier has lost about 12-15 km3 ice. For last 16 years (1990 – 2006 years) a glacier of the Zeravshan River Basin has receded on 35–55 m annually the average its speed has made about 3 m per year though in the eighties years of the last century it has made about 8 m annually. The created situation and prospect of development of the given trend of reduction of glaciers stimulates search of modern methods in preservation and effective utilization of water resources. In this plan, building of reservoirs for water accumulation and corresponding corrective amendments in planning of the water use in agriculture is actual.

P-2211-08

Impact of the Nurek Mountain Water Reservoirs in Tajikistan on Meteorological Conditions and Agriculture of Coastal Area
L. Normatov (1)
(1) Institute of Water problems, Hydropower and Ecology, Meteorology and Climatology, Dushanbe, Tajikistan
The purpose of the present research is the retrospective comparative analysis of statistical parameters of 60-year temporary ranks of temperature, atmospheric precipitation and humidity and monitoring of influence of the Nurek reservoir on a trend of change of these parameters. For establishment of influence of mountain reservoirs on possible changes of agroclimatic conditions we analyzed a trend of meteorological parameters of two regions of Dangara and Yavan of the Republic of Tajikistan with the developed agricultural branch coastal to the Nurek reservoir. Dynamics of change of humidity of Yavan district demonstrated that humidity of this area had everything the reducing character up to 1980 and was characterized by moderate increase of precipitation. After 1980 sharp increase in the near coastal area and the situation is observed. Calculations indicate about reduction of an atmospheric precipitation of Yavan for the periods 1950–1979 on 4.7 mm at their increase for the period 1980–2011 to 443 mm that in comparison with 1979 makes about 30%. Change of temperature of Yavan for the period 1980–2011 equals 1.1 C against his increase on 0.97 C for the period 1950–1979. Consequently, existence of the developed network of meteorological stations in mountain districts is pledge of receiving a real scenario of dynamics of meteorological parameters. It should be noted that continuous monitoring of meteorological parameters of the region and adequate assessment from this point of view of development of agriculture. Timely establishment of variations of weather conditions and development of technology of adaptation to the modern meteorological conditions in mountainous and highland agricultural grades steady against changes of climatic factors and stressful situations pledge of ensuring food security.

Historical and future changes in precipitation and snow in the Hindu-Kush Karakoram Himalaya region as seen by CMIP5 models
E. Palazzi (1); S. Terzago (1); J. Von Hardenberg (1); A. Provenzale, (2)
(1) Institute of Atmospheric Sciences and Climate (ISAC), National Research Council (CNR), Torino, Italy; (2) Institute of Geosciences and Earth Resources (IGG), National research council (cni), Pisa, Italy
The Hindu–Kush Karakoram Himalaya (HKKH) mountains and the Tibetan plateau are the world’s largest snow and ice reservoir and a source of most major rivers. The HKKH reservoirs are the "Third Pole". These mountains feed the most important Asian river systems, and changes in snow and precipitation dynamics in this area could severely impact on water availability for downstream populations, agriculture and energy production, ecosystems and biodiversity.

Despite their importance, precipitation and snowpack characteristics in the HKKH region are still poorly known, owing to the limited availability of surface observations in this remote and high elevation area. Global Climate Models (GCMs) still have too coarse spatial resolution to reproduce the small scale variability of precipitation and snow in orographically complex environments. Nevertheless, they may be effective in providing, even at a regional scale, a small but coherent picture of the large scale temporal and spatial patterns of these two variables in these areas. The quantification of the uncertainties in GCM simulations is essential to define the models skills in reproducing climate variability and to critically analyze future climate change projections.

We investigate how the spatial and temporal variability of precipitation and snowpack in the HKKH region is represented in historical and future simulations of the state-of-the-art GCMs participating in the CMIP5 effort, and we use innovative indices of agricultural grades steady against changes of climatic factors and stressful situations pledge of ensuring food security.
Implications of Depleting Himalayan Cryosphere under Changing Climate

S. Romshoo (1)
(1) University of Kashmir, Earth Sciences, Srinagar, India

Lidder tributary in the Upper Indus Basin (UIB) of the Alpine Himalayas, India, an important source of surface and ground water, is experiencing clear indications of climate change. In the basin, minimum, maximum and average temperature have increased and has shown significant increasing trend in all the four seasons. Precipitation is showing insignificant decrease over time in the basin, however the proportion of the snow in precipitation has decreased and the proportion of the rain has correspondingly increased.

The temperature projections also show increasing trends for the end of this century. The time series analysis of the Normalized Difference Snow Index (NDSI) from MODIS satellite shows a depletion of the snow-cover in the region. Furthermore, during the last 51 years, the glacier area in the basin has decreased from 46.09 km² in 1962 to 33.43 km² in 2013, a depletion of 27.47%. As a result of the glacier recession in the basin, the streamflow fed predominantly by snow- and glacier-melt, is overall showing a statistically significant decline. However, the spring discharge is showing an increase, might be due to the early arrival of snow, due to warmer springs. The declining streamflows have potential to adversely affect agriculture, energy production, tourism and even domestic water supplies. In the Kashmir Himalayas, one of the main climate change challenges is the rise in the elevation of snowline due to the glacier recession. The streamflow projections show a decrease in the streamflow at the outlet 11.94 m³/s is in concordance with the average decrease in the basin.

The models can be used for judicious utilization of the water resources in the region.

Climatic and Socioeconomic Drivers of Water-Related Changes in the Andes of Peru: Challenges and Future Implications

J. Seidel (1); F. Drenkhahn (2); C. Huggel (2)
(1) University of Stuttgart, Institute for modelling hydrosystems, Stuttgart, Germany; (2) University of Zurich, Department of geography, Zurich, Switzerland

One sixth of the world’s population lives in river catchments supplied by snow and glacier melt, and is therefore considered to be affected by climate change impacts on the cryosphere and water resources. In the tropical Andes glaciers have been a crucial source for societies and livelihoods for thousands of years. Nonetheless, climatic and non-climatic stressors pose potential risks and challenges to the provision of water resources and linked ecosystem services, both in terms of quantity and quality. Mountain communities in Peru are considered to be highly vulnerable to changes in water availability due to strong exposure to climate change impacts and limited adaptive capacity. However, comprehensive analyses of water-related risks considering multi-dimensional drivers across different scales in the framework of climate change are complex and barely addressed in climate-sensitive mountain regions with limited data availability.

Here we present a comprehensive data assessment study for two major catchments in the Andes of Peru: Santa River (Ancash region) and Vilcanota River (Cusco region). These river basins host the largest tropical glacier mass worldwide and are particularly exposed to climate change impacts. In the upstream areas, snow and glaciers store fresh water and buffer low flows during the dry season. Decreasing ice volume and changes in climatic patterns will subsequently alter river runoff characteristics.

For these study areas, we analyze to what extent both water supply and demand of two mountain catchments can be assessed using multiple data sources such as ground-based (air temperature, precipitation and discharge records) and remote sensing (TRMM precipitation, MODIS evapotranspiration and snow cover) data. Furthermore, we include a first assessment of socioeconomic key drivers identified by expert interviews with local and international stakeholders, decision-makers and water users. We propose an integrative water balance model approach which combines the main key variables of water supply and demand under hydrological risks considering climate-related hazards, human and natural vulnerability and exposure assessments.

The impact of climate change on mountain landscapes of the North Caucasus

V. Vinogradova (1)
(1) Institute of Geography, Russian Academy of Sciences, laboratory of Climatology, Moscow, Russia

Changes in the boundaries of high-altitude mountain belts can be treated as a proof of climate change. These changes were caused by termination of human activities. The presentation shows the role of climatic factors in changes of the boundaries and state of sub-alpine landscapes in the North Caucasus, where the transformation of land use system was observed. These are mainly mountain meadows, which were being shaped for centuries of grazing and are semi-natural formations. The system of mountain land use has been changed in the last decades. Nowadays more than 60% of sub-alpine meadows are abandoned.

Heat and moisture are the limiting factors of vegetation existence. The estimate of changes in heat and humidity was made for the territory of 42-44N, 42-44.5E using vegetation index (NDVI), the index of vegetation conditions (VC), Satellite Climatic Extreme Index (SCEI) and the sum of active temperatures (air temperature above +10 °C).

Analysis of index changes shows normal humidification on the slopes of the main Caucasian ridge throughout the more humid period (2000-2006). In the second – dry period (2007–2013) for most of the southern European Russia, the situation is changing. In the foothills moisture decreases, whereas in the middle mountains the increase in moisture is seen. The estimate of the amount of active temperatures and precipitation for the period of modern warming (1981-2010) shows the increase of these parameters in the early twenty-first century in the foothills of the North Caucasus. These changes cause the increase in vegetation in the middle mountains of the North Caucasus. It is evidenced by the growth of vegetation index (NDVI) at the beginning of the twenty-first century in this area. And in the areas with low altitudes (500–1000 m) vegetation index decreased after 2006, reflecting degradation of vegetation state. In the middle mountains the increase of vegetation index is observed, showing the improvement on conditions of vegetation.

In the middle mountains of the North Caucasus regeneration of natural boundaries of altitude zones is observed: the expansion of mountain-forest belt and restoration of pine forests on the southern slopes; the restoration of mountain meadow steppe and steppe sub-alpine meadows on former agricultural terraces; northern slopes overgrown with crooked birch. These processes occur in the context of climate change (rising temperatures, increasing moisture) and reduce of human impact. Thus, climate change and weakening economic activity on the territory lead to restoration of vegetation in the area of middle mountains.

Researches were supported by RFFI grant № 14-05-00233A.
**K-2212a-01**

**Impacts of Climate Change on Freshwater Resources and Managing Global Risks**

T. Oki (1)
(1) University of Tokyo, Tokyo, Japan

The real hydrological cycles on the Earth are not natural anymore. Humans are now driving changes in atmospheric processes through emission of green-house gases and land cover changes directly and indirectly. Global mean temperature rise is proportionally proportional to the cumulative total anthropogenic CO2 emissions from 1870 (AR5, IPCC WG1). Temperature rise itself will have direct impacts on the availability of water resources through changing flow regimes in snow-dominant or glacier-effluent river basins, and it will also be associated with sea level rise because thermal expansion is one of the major causes of observed and projected sea level rises. Further, climate change is projected to alter hydrological cycles: changing temporal and geographical patterns of hydrological components, such as precipitation, evapotranspiration, runoff, and groundwater recharge, and particularly in their extremes. Consequently, the frequency of floods and/or droughts is projected to increase in some parts of the world.

However, as articulated in the AR5 of IPCC WG1, "Risk of climate-related impacts results from the interaction of climate-related hazards (including hazardous events and trends) with the vulnerability and exposure of human and natural systems", increasing frequency of natural hazards, such as torrential rainfall or long–lasting heat wave, alone will not cause damages on human and natural systems, and both climate and social changes are relevant for planning sustainable development in the future.

ARS (WGII) also says "Significant co-benefits, synergies, and tradeoffs exist between mitigation and adaptation and among different adaptation responses; interactions occur both within and across regions". Mitigation and/or adaptation actions should not be planned in an isolated manner, but should be integrated into wider frameworks, such as integrated water resources management and sustainable development. It would preferably be integrated into a risk management framework assessing and managing possible global risks, and ultimately pursue increasing human well–beings.

**K-2212a-02**

**Hydrometeorological and hydroclimatic worldwide monitoring, data sharing, cooperation and services**

B. Stewart (1); H. Lins (2)
(1) former Director, Department of climate and water, wmo, Croydon, Victoria, Australia; (2) President of WMO Commission for Hydrology, Washington, United States of America

Freshwater resources are essential to all forms of life and, in a changing environment, hydrometeorological and hydroclimatic information are critical to ensure that resources are managed sustainably. Our precious freshwater resources are under stress due to a range of factors. These include, inter alia, growing populations, increasing food and industrial production and a changing and variable climate. Unless we improve the availability of, and access to, good quality hydrometeorological and hydroclimatic information, we will not be able to fully understand and manage our water resources in a sustainable manner and monitor the implications of future decisions.

In this regard, the current status of monitoring climatic change and its impacts, with an emphasis on global freshwater resources is reviewed. In particular, the value of comprehensive hydrometeorological and hydroclimatic monitoring is described, including international efforts to facilitate and improve data collection and accessibility. Benefits from monitoring include improved understanding of the state and variability of freshwater resources, as well as reduced uncertainty in resource management decision–making under climate change. Additionally, the status of, and efforts associated with, the promotion of regional and international data sharing are described. The value associated with the combination of monitoring, data sharing and cooperation between relevant agencies are realized through the services that can be provided. Finally, the efforts of the hydrological community to provide hydrological services, the importance of a risk management framework for the collection and presentation of data, the development of associated information systems, data registries, and web services for data sharing are emphasized.

In order to manage our freshwater resources in a sustainable manner, we must learn from the mistakes of the past and support the collection of hydrometeorological and hydroclimatic data into future. This requires two actions: 1) reversing the current trend in declining monitoring stations and the data and information derived from them; and 2) improving the collection, processing, and presentation of these data through innovative new technologies.

**K-2212a-03**

**Responding to the Challenges of Water Security: the Eighth Phase of the International Hydrological Programme 2014-2021**

B. Jimenez-Cisneros (1)
(1) UNESCO, IHP, Paris, France

This paper presents the major water challenges at global, regional and local level, including adaptation to climate change, based on the AR5 IPCC findings. It relates how the International Hydrological Programme (IHP) will respond in its VIIth Phase to water–related risks and seize opportunities to contribute to water security at all levels. Cooperation between science and innovation and policy lie at the core of this strategy.

Management of natural resources must draw on science and innovation to be sustainable. From this perspective, the UNESCO–IHP Member States periodically define priorities for research, technological development, innovation and education. To implement the priorities in a coordinated manner, Member States works with the IHP Secretariat based at UNESCO HQ, as well as the UNESCO “Water Family”, consisting of UNESCO–IHE, a Category I Centre located in the Netherlands; the World Water Ass. Assessment Programme, based in Italy, which operates the UN World Water Development Report; thirty Category II Centres under the auspices of UNESCO; and thirty–five water Chairs around the globe.

IHP’s role in this context is to put in place procedures for the use of knowledge and innovation to adapt to climate changes impacts in the water sector, and to increase resilience to water-related disasters.

**O-2212a-01**

**River flood risk and climate change**

Z. Kundzewicz (1)
(1) Institute for Agricultural and Forest Environment, Polish Academy of Sciences, Department of Climate and Water Resources, Poznan, Poland

River floods are an important problem area related to freshwater resources, at any spatial scale from local to global. More than 10% of the global population are currently living in flood-prone areas and about 1% of the global population are, on average, exposed to floods each year. Average global flood damage reaches tens of billions of US dollars and the number of fatalities amounts to thousands. Flood losses are higher in developed countries, while relative fatality rates and economic losses expressed as a proportion of GDP are higher in developing countries.

Observations of changes in climate, hydrological /
terrestrial, and socio-economic systems influencing flood risk are examined. Despite the widespread use of precipitation-based signals, and its possible link to changes in flood patterns, no gauge-based evidence had been found for a climate-driven, globally widespread change in the magnitude and frequency of floods during the last decades. There are strong regional and sub-regional variations in the trends. Moreover, it has not been generally possible to attribute rain-generated peak streamflow trends to anthropogenic climate change. Indeed, economic costs from floods have greatly increased, but this has been primarily attributed to increasing exposure and damage potential and not to climate change.

Further, model-based projections for the future are critically discussed. Projected changes from both global and regional studies indicate that it is likely that the frequency and severity of floods will increase. Physical reasoning suggests that projected increases in intense rainfall would contribute to increases in projected increases in flood hazard. Moreover, flooding and earlier spring peak flows in snowmelt-fed rivers are expected in the warmer climate. Increase of flood hazard is projected over many areas.

Studies that project future flood losses and fatalities indicate that, when no adaptation is undertaken, future anthropogenic climate change is likely to lead to increasing flood losses, along with the increase in exposure linked to ongoing economic development, and the total increase would depend on the degree of warming.

Finally, uncertainty in our understanding of past floods and projections for the future is reviewed, with identification of gaps in knowledge. The impacts of climate change on flood characteristics are highly sensitive to the detailed nature of those changes and presently we have only low confidence in numerical projections of changes in flood magnitude or frequency resulting from climate change. Attention is drawn to the fact that over less than a decade, projections of flood hazard in Europe have dramatically changed. This is of vast practical relevance, hence interpretation of such changes has to be sought, related to both different climate scenarios and different modeling approaches.

O-221a-02

Adaptation to changing water demand and climates in Sub-Saharan Africa: the role of groundwater

R. Taylor (1)

(1) University College London, Geography, London, United Kingdom

Freshwater demand in Sub-Saharan Africa (SSA) is expected to increase substantially in coming decades with projected rises in land under irrigation and water withdrawals, especially for intensified agriculture. Anthropogenic warming is projected to further amplify variability in rainfall and river discharge that is already the most extreme in the world. Current metrics of freshwater availability (e.g. water stress index, relative water demand) misrepresent the “water crisis” in SSA as they greatly exaggerate freshwater demand, define renewable freshwater resources in terms of mean river discharge and do not account for the groundwater storage in Africa (~0.66 million km3) is more than 100 times annual renewable freshwater resources, and more than 20 times the volume of freshwater stored in the major lakes. Although substantial quantities of fossil groundwater in Africa have long been known to exist and are heavily exploited in arid landscapes remote from people (e.g. Great Man-Made River Project), less well understood is the contribution of the vast groundwater storage to the water balance of SSA where people live. The extent to which this groundwater resource is both accessible and renewable remains unclear. Recent research based on ground-based observations in semi-arid and humid areas of Tanzania and Uganda reveals the strong dependence of groundwater recharge on heavy rainfall events (>10 mm over 24 h) and extremes of rainfall associated with the El Niño Southern Oscillation (ENSO). Consequently, the shift to fewer but heavier rainfall events projected under climate change may enhance groundwater recharge while reducing near-surface soil moisture and exacerbating flooding. Under such circumstances, increased use of groundwater resources not only to supplement soil moisture through irrigation but also to meet increased freshwater demand may lead to increased risk of groundwater depletion in SSA. Increased reliance upon groundwater resources has led to groundwater depletion of regional aquifer systems in the USA, China and India through competitive abstraction and aquifer mismanagement. In contrast, aquifer systems underlying much of SSA are localized and characterized by low transmissivities and low storage. ‘Small is beautiful’ since these systems restrict the impact of uncontrolled groundwater abstraction witnessed in other groundwater-dependent countries and enable low-intensity abstraction for which the impacts of overuse are largely localized. Thus, the prevailing geography naturally resolves the ‘Tragedy of the Commons’ that complicates management of productive, regional aquifer systems. Indeed, the potential for distributed, low-intensity groundwater use strongly complements land tenure systems in SSA that are characterized by a large number of distributed, smallholder (< 1 hectare) plots.

Groundwater in SSA therefore represents a low-cost, distributed and potentially renewable store of freshwater that can enable many communities to adapt to changing water demand and climates. Two key physical challenges that currently constrain the realization of this potential are: (1) reducing the prohibitively high cost of drilling that currently impedes the development of groundwater by small landholders; and (2) resolving the aggregated impact of multiple low-intensity groundwater users to ensure the continuity of groundwater supplies and groundwater-dependent ecosystems.

O-2212a-03

Groundwater on North Sea islands in a future climate – a geophysical approach

H. Wiederhold (1)

(1) Leibniz Institute for Applied Geophysics, Hannover, Germany

For the North Sea Region climate change scenarios predict a shift of precipitation to the winter season leading to an enhanced groundwater recharge and rising water table. Additionally a sea level rise is expected leading to a new balance of freshwater and groundwater in the subsurface with consequences for, e.g., water supply, wetland drainage, construction stability. In the EU Interreg project CLIWAT (climate and water) the consequences of climate change to the groundwater systems were investigated in seven project areas in Denmark, Germany, the Netherlands and Belgium (CLIWAT Working Group 2011, Hinsby et al. 2013). Here the approach is shown exemplarily for the German North Sea island Borkum (Sulzbacher et al. 2012, Wiederhold et al. 2013).

The main challenge in the study of coastal aquifers in Northern Germany is the freshwater/saltwater environment. The water supply of the North Sea offshore islands is in many cases restricted to a freshwater lens and intrusion of saltwater into coastal aquifers is one of the most important consequences of climate change to groundwater utilization. To study the impact of climate change on the freshwater lens of a barrier island, a density-dependent groundwater model was developed. The structure and parameters of this model were designed using information from boreholes and various geophysical and hydrogeological investigations. To characterize the hydrogeophysical setting of a freshwater/saltwater system, we need a description of the actual situation including temporal changes in the freshwater/saltwater transition zone. This concerns the study of water salinity and its changes. Due to the strong contrast in electrical conductivity between seawater and freshwater, resistivity and electromagnetic methods are most suitable to map salinity in the subsurface. To overcome ambiguity in interpretation, the combination with methods such as nuclear magnetic resonance or seismic tomography is successful.

This data were used to generate a hydraulic model for density-dependent groundwater modelling that is able to predict the long-term behaviour of the system under changing climatic conditions. To monitor the temporal behaviour, permanently installed installations are a cost-efficient alternative to repetitive soundings. The data acquired in periods of years or decades can help to improve the groundwater model and its implications.


2212a–POSTER PRESENTATIONS

P-2212a-01

Nubian Sandstone Aquifer System

EHM. Ahmed (1)
(1) Lead Author, WG III, IPCC, climate change and sustainable development, Cairo, Egypt

The Nubian Sandstone Aquifer System (NSAS) is the world’s largest known fossil water aquifer system. It is located underground in the Eastern end of the Sahara Desert and spans the political boundaries of four countries in north-eastern Africa, it covers a land area under boarders for Egypt, Libya, Sudan and Chad. The geographical position between latitude 14°–33° north; longitude 19°–34° east. It contains and stored water volume 150.000 km2.

Many studies were made looking for the hydro geological setting of the area’s aquifer; its results indicated that lithological characteristics and tectonic settings are having a substantial effect on groundwater flow patterns and the area’s overall aquifer potentiality.

Many surface bodies and groundwater traverse boundaries with no restrictions; any action which may be caused by one country could affect the water resources, and also could vary in significant consequences to the quality or quantity of water in another country.

In sub-Saharan Africa, freshwater withdrawals for agriculture are less than in Asia, Europe and North America. Also, estimation of freshwater demand and use are unknown. Withdrawals for irrigation and industry which are over 20% times that required for domestic water use. Groundwater in many parts of sub-Saharan Africa can play a strategic role in adapting to changing freshwater availability and impinge on food production and security through groundwater-fed irrigation.

The actual withdrawal rates as follows; Egypt draw 1029 Million m3/yr; Libya 851 Million m3/yr; Sudan 406 Million m3/yr and Chad Million m3/yr. There’re two different systems because of different water bearing strata; The Nubian Aquifer System (NAS), the second system is the Post Nubian Aquifer System (PNAS).

One of the great projects that consumption a huge amounts of Nubian Aquifer System (NAS) is called “The Great River”, which be constructed on 1980. Withdraw water for municipal, industrial and agricultural use should be enough to produce adequate water and food to the countries own needs, it reduces the dependency on imports from foreign market.

So, we have to manage and implement a good convention for states that sharing in the same aquifer to control their draw and to implement a good plan to recharge the same aquifer using floods and other resources.

P-2212a-02

Green and Blue Water Impact Assessment under AR5 Climate Change Scenarios in Asian Monsoon Region

D. Bae (1); M. Lee (2)
(1) Professor, Sejong University, Civil & Environmental Engineering, Director, center for climate change adaptation for water resources, Seoul, 143–747, Republic of Korea; (2) PhD candidate student, Sejong University, Department of civil engineering, Seoul, 143–747, Republic of Korea

The evaluation of continental-scale water availability is an important issue for sharing and distribution of transboundary water resources. Water resources are abundant in some regions, but water scarcity has been a major disaster in many other regions. In particular, the water resources in Asia monsoon region are more important, but also cause serious drought problems. There are various reasons for these water-related disasters, but the current climate change will be one of the critical triggers for the upcoming water scarcity.

In this sense, the understanding of climate change impact on green and blue waters and the development of climate change adaptation framework for water resources over the region will be important and urgent issue. The objectives of this study are to investigate the future climate change impacts on green and blue waters in addition to the changes of temperature and precipitation and to delineate the highly variable regions under future AR5 climate change scenarios in the Asian Monsoon region. Several GCMs representing the better performance in this region were selected and used for climate change projections. The change factor method with bilinear interpolation method was used to project climate change at 0.5 degree horizontal grid resolution. The Variable Infiltration Capacity (VIC) macroscale hydrological model was employed to project runoff using future climate change scenarios. Average temperature, precipitation, green and blue waters were projected for all future periods i.e. 2020s, 2050s, and 2080s. These findings can be useful for the better implementation of climate change adaptation strategies and wise water resources management in this region.

P-2212a-03

Spatial distribution of the vegetation and rainfall over West Africa during the last three decades (1981-2012) and associated atmospheric patterns

A. Bamba (1); A. Diedhiou (2); B. Dieppois (3); P. Thierry (4); A. Konare (5); A. Diawara (6); B. Kamagate (7); S. Issiaka (8)
(1) Université Nangui Abrogoua, SGE, Abidjan, Ivory Coast; (2) Institute of Research for Development (IRD), LTHE - University Grenoble Alpes, Grenoble Cedex 9, France; (3) Université de Rouen, Mont-Saint-Aignan, France; (4) University of Grenoble-Alpes, LTHE, Grenoble, France; (5) Université Felix Houphouet Boigny, Cocody, Ufr sst, Abidjan, Ivory Coast; (6) University Felix Houphouet Boigny - Cocody, Abidjan, Physic, Abidjan, Ivory Coast; (7) Université Nangui Abrogoua, Laboratoire de géosciences et enonnement, Abidjan, Ivory Coast; (8) Université Nangui-Abrogoua, Ufr sge, Abidjan, Ivory Coast

Decadal variability of the rainfall and the vegetation over West Africa is revisited from 1981 to 2012 using Climatic Research Unit (CRU) observation rainfall data and Normalized Differentiel Vegetation Index (NDVI) from NOAA. From decade 80s to 90s, we observe a significant return to wetter conditions over West Africa confirmed during the decade 2000s (00's) especially over Central Benin and all the western side of Nigeria where there are a decrease in annual rainfall magnitude. From decades 80s to 90s, we observe a regreening of the Central Sahel and Souns. From decade 90s to 2000's (00's), the vegetation over Central Benin and the Coastal areas, mainly over the Guinea Coast, Soudano-Guinean and Western Sahel regions. Factors of the atmosphere associated with the vegetation and rainfall changes over West Africa during the last three decades was investigated: During the last two decades, the West African monsoon (at 925hPa) and the Tropical Easterly Jet (at 200hPa) have weakened. The African Easterly Jet (at 700hPa) is weaker. This synoptic configuration is known to be favorable to wet conditions.

P-2212a-04

Synthesis Report on Climate Change Vulnerability Assessment over Niger River Basin

G. Bogale (1)
(1) ACMD, Climate and environment, Niamey, Niger, Republic of Niger
The Niger River Basin encompasses an area of 2.2 million square kilometers, a third of which is hydrologically active. Development activities are going on along the basin such as mining, construction of dams for generating electricity and irrigation. The construction of dams across the Niger River basin by riparian countries. Most of the riparian countries recorded economical growth in recent years. The sustainability of the economical development and the achievement of development goals are threatened by climate change.

In this paper, we tried to assess climate change vulnerability over the basin. The climate of the region varies from tropical humid climate to arid climate and one of the most vulnerable regions to climate change. The Basin suffered from desiccation in 1970s and 1980s and catastrophic recent rainfall fluctuations. The drought of 1984 reduced the GDP of Mali and Niger by 9% and 18% respectively. The inner delta is one of the most vulnerable parts of the river basin because of the dependency of millions of lives and livelihoods including the pastoralist on it.

Studies of National Adaptation Programme of Action of riparian countries indicated that the surface temperature is expected to increased by less than 10°C in the second half of the 21st century. The surface temperature is expected to rise between 3-6°C at the end of the 21st century under 20th century. The most vulnerable regions to climate change are West Africa, 25% of the disasters occurred in West Africa which are related to hydro-meteorological disasters of Sub-Saharan countries. The Niger River basin was clearly figured out in the national and international reports. The rainfall variability in the Niger River basin is associated with the sea surface temperature of global oceans, ENSO and complex interacting processes including land surface and desert dust aerosols.

Among the hydro-meteorological disasters of sub-Saharan Africa, 25% of the disasters occurred in West Africa which is the second vulnerable region to climate change. The number of days with heavy rainfall is expected to increase in 21st century in West Africa. In the near future, the projected mean sea level rise coupled with land subsidence due to the oil and gas extraction in the Niger delta will threaten the existing physical, biological and socioeconomic systems.

Rain-fed agriculture is dominated the Niger River Basin which is highly sensitive to climate variability and change. The population growth compounded with climate variability and change is a major challenge for agriculture sector to meet the demand. The major impacts of climate change for agricultural sector are a reduction in crop yield and total farm level as well as the death of livestock and reduction of productivity.

The Niger River basin is considered as one of the basin which is affected by fresh water shortage in West Africa and the River itself influenced by the ground water base flow. Climate variability and change impacted the river basin in the past. A significant decrease in rainfall resulted in two fold decrease in the surface and subsurface runoff. The projection of rainfall in West Africa is uncertain due to the disparity of climate models; however, the water sector will be under stress as result of population growth, urbanization, water for agricultural growth, and land use change.

The basin is affected by climate sensitive diseases such as malaria, meningitis, cholera, dysentery and diarrhea. The expected increase in surface temperature will exacerbate the incidence of climate sensitive disease in the basin. The most commonly observed climate factors are reduced rainfall and an outbreak of malaria revealed that the malaria belt zone will shift 10 to 20 south wards in West Africa.

In developing regions like Africa, availability and access to freshwater largely determines patterns of economic growth and social development. Burkina Faso, as others Sahelo–Sudanian countries pledged for some decades to control water resources after the severe droughts that occurred during the 1970s and 1980s through the construction of small reservoirs. Thus, thousands of small reservoirs dot the landscape and they are used for multiple purposes with especially irrigation in order to increase food production. The Boura reservoir, located in the southern of Burkina Faso, is a representative pilot site of many small reservoirs in the Volta Basin in West Africa. The ungauged catchment area upstream of the Boura dam of about 150 km² is lying to the Centre West Region, Burkina Faso and Upper West Region, Ghana. This study aims to assess the performance indexes such as reliability, resilience and vulnerability of the Boura reservoir under the climate change conditions.

The methodology is organized in steps: (i) Firstly, climate change scenarios for the periods 2041–2070 and 2071–2100 relative to the reference period (1971–2000) were projected by using the outputs of regional climate model RCA4 (Rossby Centre Atmosphere model, version 4) under two emission scenarios (RCP4.5 and RCP8.5); (ii) Secondly, the impact of climate change was then investigated on the input runoff of the Boura reservoir by using the hydrological model GR4j (daily lumped four-parameter) for the future periods and also on the crop water requirement of the irrigation scheme using the FAO approach. Thirdly, the simulation of reservoir performance in the delivery of agricultural water demand was implemented by using the water evaluation and planning (WEAP) model.

The analysis of the inter-annual average changes in rainfall and potential evapotranspiration (PET) between the future two 30 year horizons (2041–2070 and 2071–2100) and the reference period (1971–2000) shows increasing trends with increases up to +23% for rainfall and +9% for PET, dependent on the RCP emission scenario (RCP4.5 or RCP8.5). These projected changes in rainfall and PET will cause higher inter-annual variability of future inflow to the Boura reservoir compared to the reference period, necessitating increased reservoir capacity to meet the future irrigation water demands. However, the performance indexes of system revealed that failures in agricultural water demand satisfaction would be observed in the future periods. In terms of overall performance, the reliability and vulnerability indexes decreased in the future relative to the reference period, especially for the socio-economic development scenario with an increase in agricultural water demand under climate change conditions.

This approach enable a comprehensive understanding of the functioning of a water storage reservoir under future climate scenarios and can be a robust tool to predict future challenges faced by water supply systems under climate change conditions.

**P-2212a-06**

**Result of numerical modelling of groundwater resource in the Shiraki catchment**

M. George (1); N. Zhukova (1); M. Todadze (1)

(1) Institute of Geophysics, Ivan Javakhishvili Tbilisi State University, Tbilisi, Georgia

Eastern Georgia encounters, due to its semiarid climate, a big deficit of 1040 million cubic meters of water for irrigation and domestic use. One of the most important examples is the agricultural area of Shiraki Plain, which occupies over 80.000 km² on a large, partly artesian aquifer of the Alazani basin and a part of the aquifer which is drained by the rivers Alazani and lori (1). In order to assessment water resource, numerical model of groundwater hydrodynamics was elaborated for this area based on the conceptual model which is based on the geological peculiarities of the area (geophysical, hydrogeological, hydrological, etc). Model of the aquifer have been processed by special software Visual Modflow Package. In order to assessment water resource, a numerical model of groundwater was elaborated for Shiraki area. It is consists of 3 layers. Each layer represents a porous material with different infiltration properties. The model was calibrated in transient transport mode to track the concentration of tritium and isotope located in Shiraki area. Tritium was assigned as a single mobile species, not reacting with chemical elements and concentrated in water, what allowed determining the residence time of groundwater flow. The model estimated
ABSTRACT BOOK

and thereby account for the loss in hydrological models.

used to develop and calibrate a specific model of the NID, and the year-to-year variations. Furthermore, information determine both the development of storage in one year, extent of the flood and water loss across the NID helped assessments of flooded areas refined the NID water balance abstraction from irrigated fields and direct precipitation in dry periods, resulting in actual evapotranspiration loss of the flooding over the NID shows that the flooded areas hysteresis as flooding recedes, and the timing of the inflow levels data, and flooded areas within a non-linear and temporal resolution. Characteristics of the extent be used to monitor flood dynamics with adequate spatial and policy development. projects lack transparency and and government. Unplanned growth of urban area further shortages and contamination that directly affect health and velocity as well as groundwater age for Shiraki area. It is recommended to enhance the use of waters from the karstic formations as alternative drinking water sources. It has been carried out using Indian remote sensing data, Survey of India topographical sheets and GIS techniques. During the course of a study, a series of thematic maps covering climatic parameters and anthropogenic activities have been prepared to understand rainfall pattern, surface hydrology, geo-hydro-morphology, rainfall pattern and its impact on urban water resources. It was found that increasing pressure of population and un-systematic anthropogenic activities have made negative impact on water resources. It encroached upon lakes, rivers, streams, and ponds etc in the vicinity of urban area. As a result, out of total 518 rivulets in urban area and surrounding, 13 first order, 37 second order and 10 are of third order stream are completely blocked by settlements (Total 60). Out of 2600 wells, 1116 well/tube wells have stopped recharging due to increase in pavement area between years 1986 to 2003. Seven fresh water reservoirs have dried-up which were supplying drinking water to Jaipur city - The surface drainage network of rain water has been converted into municipal sewerage - Local source of water contamination closed due to scarcity of water - Recharge of ground water has stopped due to increased pavement area for urban development like infrastructure development, industrial development and other urban development activities. Finally, it is suggested that by using remote sensing and GIS techniques one can prepare an integrated plan for urban development in which surface water bodies can be protected which in turn would take care to recharge ground water and also provide the surface water in decentralized manner in the urban area.

Flooded area characterization and loss estimates for improving the water balance of the niger inland delta, malI

M. Ibrahim (1) ; D. Wissel (2) ; A. Abel (3)
(1) University Abomey-Calavi, WASCAL, DP Water Resources and Climate Change, Cotonou, Benin; (2) University of Bonn Center for development research (zeF), Bonn, Germany; (3) Univesite d'Abomey-Calavi, Graduate research program on climate change and water resources, Abomey-Calavi, Benin

Water availability is an ongoing challenge for West African countries in general, and the Niger River basin in particular. The Niger Inland Delta (NID) has experienced annual flood events from the Niger and Bani Rivers. During such events, the flooded area can cover 40,000 km², and extend to 350 km long and 100 km wide in Mali. While these NID events can have considerable influence on downstream flow regimes due to water loss significantly impacting water availability, the processes that occur in NID are not fully incorporated in the conceptual development of many hydrological models of Niger Basin runoff. Though several studies in this region have developed conceptual models to represent hydrological processes in the system, the models have been criticized for their limitations and uncertainties. In this paper explicit representation of all the hydrological processes. This paper discusses an attempt to better assess the NID hydrological processes by considering more physical information about the system, and incorporating wetland processes into an existing hydrological model to improve model simulations of the basin.

The approach illustrates how flooded surface area estimates from large amounts of remote sensing data can be used to monitor flood dynamics with adequate spatial and temporal resolution. Characteristics of the extent of flood areas are determined from monthly scale inflow levels data, and flooded areas within a non-linear regression based model. Previous correlations between flow levels and flooded areas were refined to account for the hysteresis as flooding recedes, and the timing of the area expansion. The model of the spatiotemporal extent of the flooding over the NID shows that the flooded areas varied between 25,000 km² in wet periods and 2,000 km² in dry years as a result of an activity range of between 17 km³ and 10 km³. The contribution of water abstraction from irrigated fields and direct precipitation assessments of flooded areas refined the NID water balance and estimation. The results of the timing and extent of the flood and water loss across the NID helped determine both the development of storage in one year, and the year-to-year variations. Furthermore, information about the NID flood dynamics and water budget can be used to develop and calibrate a specific model of the NID, and thereby account for the loss in hydrological models.

Impact of Rapid Urbanization on Water Resources in the Context of Climate Change (A Case Study of Urban Area through Multi-Temporal Remotely Sensed Data and GIS)

KN. Joshi (1)
(1) Institute of Institute of Development Studies, Natural Resources Management and Environment (Remote Sensing), Jaipur, Rajasthan, India

One of the many environmental problems incurred by climate change is creating a negative impact on water resources in urban areas. The effects of climate change on water quality and availability are significant, including such impacts as contamination and the direct and indirect effects of people and proper functioning of urban development and government. Unplanned growth of urban area further deteriorates the situation. The present paper provides an overview of the effects of rainfall variability due to climate change coupled with urbanization on water quality as well as quantity in Jaipur urban Agglomerates, the most populous area in the state of Rajasthan (India). The study

Developing adaptation strategies to face the impact of climate change on the freshwater resources of India

SN. Krishnapillai (1)
(1) Nansen Environmental Research Centre (India), Kochi, Kerala, India

Major challenge associated with the management of freshwater resources in India is the abnormalities and uncertainties in climate. With changing climate, increasing water demands in the domestic, agricultural and industrial sectors, and fast deterioration of the water resources, India is heading towards a water crisis. Life of millions living in climate sensitive river basins and wetlands make India one among the countries highly vulnerable to the impacts of climate change. Drylands are prone to increasing temperature and decrease in rainfall pattern and its impact on urban water resources. it covering climatic parameters and anthropogenic activities during the course of study, a series of thematic maps has been carried out using Indian remote sensing data, Survey of India topographical sheets and GIS techniques. During the course of a study, a series of thematic maps covering climatic parameters and anthropogenic activities have been prepared to understand rainfall pattern, surface hydrology, geo-hydro-morphology, rainfall pattern and its impact on urban water resources. It was found that increasing pressure of population and un-systematic anthropogenic activities have made negative impact on water resources. It encroached upon lakes, rivers, streams, and ponds etc in the vicinity of urban area. As a result, out of total 518 rivulets in urban area and surrounding, 13 first order, 37 second order and 10 are of third order stream are completely blocked by settlements (Total 60). Out of 2600 wells, 1116 well/tube wells have stopped recharging due to increase in pavement area between years 1986 to 2003. Seven fresh water reservoirs have dried-up which were supplying drinking water to Jaipur city - The surface drainage network of rain water has been converted into municipal sewerage - Local source of water contamination closed due to scarcity of water - Recharge of ground water has stopped due to increased pavement area for urban development like infrastructure development, industrial development and other urban development activities. Finally, it is suggested that by using remote sensing and GIS techniques one can prepare an integrated plan for urban development in which surface water bodies can be protected which in turn would take care to recharge ground water and also provide the surface water in decentralized manner in the urban area.
groundwater is an essential resource. it provides baseflow to lakes and rivers and supports numerous terrestrial ecosystems. it is also paramount to freshwater and food supply. globally it covers the demands for around 36% of domestic water and 40% of irrigation water requirements. groundwater is often regarded as a key resource for adaptation strategies to climate change. aquifers often represent large stores of slowly evolving water. groundwater has generally a lower variability and vulnerability than surface water. groundwater resources are consequently more resilient to drought and the impact of human activities than surface water.

under the international hydrological program (ihp), the unesco is home to a scientific network examining the relationships between groundwater resources and global change, called graphic (groundwater resources assessment under the pressures of humanity and climate change). the graphic community is composed of academics, researchers, government employees, and professionals from the water industry located across 34 countries. coordinating international and national collaboration, graphic aims to strengthen global research efforts on groundwater impacts from climate change and adaptation strategies. this presentation provides a geographic synopsis of progress made and lessons learnt to date by the graphic network.

through a number of case studies in a variety of climatic and geologic settings, graphic has identified challenges that are important when considering the inclusion of groundwater in climate change adaptation strategies. though generally less responsive than surface water, groundwater can still be substantially impacted by climate change. the magnitude of this impact can vary greatly from region to region. at the same time, compounding effects of hydro-climatic changes also impact groundwater. it is possible to identify a number of hotspots where groundwater may be particularly vulnerable to climate change and will require careful sustainable management.

key lessons learnt from graphic network include the need to account for groundwater in 1) monitoring of freshwater resources; 2) climate models; 3) land surface and water models; and 4) the management of transboundary basins. there is a great need to include and more carefully consider groundwater into climate change adaptation schemes and strategies.

future activities will include, amongst others, applying satellite gravimetry for evaluating trends in groundwater storage and identifying hotspots of aquifer change in regions where data access is very limited either because of data scarcity or accessibility. such activities will contribute to establishing water budgets at aquifer scale for better-informed water management decisions and policies.
L'eau virtuelle des produits agricoles d'importation : Un moyen de contrecarrer le problème du manque d'eau en Algérie

B. Mounsouche (1)

(1) Ecole Nationale Supérieure Agronomique (ENSA) ex INRA, Génie Rural (Hydraulique Agricole), Alger, Algérie

Algeria is ranked among the 17 countries that suffer most from lack of water worldwide. Indeed, with less than 300 m³ capita of renewable water, Algeria has less than 30% of the theoretical scarcity threshold set by the World Bank in 1000 m³/hab./an.

Being unable to expand its agricultural land UAA and / or increase irrigated areas, to fill the food gap, Algeria resort to massive food imports, especially cereals and their derivatives.

Added to these non-food agricultural products.

These imports, although they represent a major financial drain for the country, have at least one positive aspect represented by the virtual impressive amounts of water they provide to Algeria estimated at over 40 billions m³ 2012.

It is in this framework that guides our study in which we try to quantify these virtual amounts of water that contribute greatly temporarly relieve the country of its water shortage problem.

Key words: Water scarcity, food security, water resources, virtual water, Algeria.

P-2212a-14

Climate Change and water resources in the Maghreb

B. Laignel (1) ; Z. Nouaceur (2) ; I. Turki (1)

(1) University of Rouen, UMR 6143 M2C, Mont Saint Aignan, France; (2) University of Rouen, Umr 6143 idees, Mont Saint Aignan, France

The Mediterranean area, known as hot spot area of Climate Change by IPCC, is expected to increase mean annual temperatures between +2.2°C and +5.1°C, a decrease mean annual rainfall between ~5 and ~35 % and an increased of extreme events, in 2100. The combination of Climate Change and human impact could lead to water shortage for 290 million people (Plan Bleu of United Nations), particularly in North Africa.

The aim of this work is to provide an overview of the climate change and its effects on the water resources, at the Maghreb scale for the temperature and rain evolutions (30 synoptic stations located in the North and center of the 3 countries of the Maghreb, from 1970 to 2013) and 5 watersheds for the water resource (Soummam and Khebir Rhumel in Algeria, Tensift and Sebou in Morocco, Cap Bon in Tunisia). This study is performed in the framework of the 2 AUF and PHC Maghreb projects on the evolution of the water resource in Maghreb.

At the Maghreb scale and the studied watersheds, we observe an increase of minimum and maximum annual temperatures from the 80s. We observe 3 periods on the rainfall time series: a humid phase before the 80s, then several years of drought from 80s to the early 2000s, then a return of more humid phase with more of storm events.

However, it is difficult to distinguish and quantify the respective roles of the climate change and anthropogenic impact on the evolution of the water resources. The combined effects of these two factors led to a decline of the quantity and deterioration of the quality of water resources. Indeed, the groundwater, the main drinking water resource in the Maghreb, showed a strong decrease, which can reach 50 cm to 1 m per year, and a deterioration of the water quality by infiltration of the anthropogenic pollutants from surface water (rivers) and by the coastal aquifers (related to the seawater intrusion), such as the examples of the Haouz and Sais aquifers in Morocco (Marrakech and Fès regions) and Cap Bon aquifer (North of Tunisia).

Nevertheless, a study of the hydrological variability carried out on 2 watersheds (Soummam and Tensift), by wavelet analysis, showed similar energy bands or variability modes (1, 2–3, 5–7, 15 years) in rainfall, streamflow and aquifer piezometry: 1, 2–3, 5–7 and 8–15 years. Moreover, 3 major temporal discontinuities are observed around 1970-1975, 1990-1995 and 2000-2005. Thus, these discontinuities were also found in other hydrosystems on both sides of the of the Mediterranean Sea and the Atlantic Ocean, in various climatic and geomorphological contexts (USA, NW Europe, N Africa), in different hydrological compartments (surface and groundwater) and at various spatial scales (watersheds smaller than 1000 km² and large rivers): the Serio watershed (Italy) and 3 major temporal discontinuities (1900–1995) and the small high–low normans watersheds, Mississippi, Colorado and Texas small watersheds. Therefore, these discontinuities can be described as global disruptions. In addition, they are associated with the phenomenon of climate change and therefore be described as climatic discontinuities at the global scale. There is no satisfactory explanation of the phenomena causing these discontinuities, although the first discontinuity coincides with the second period of global warming (which also began in the early 1970s) and the second coincides with an apparent intensification of warming. However, the link between these phenomena is not yet established.

P-2212a-15

Impact of climate change and overexploitation in semi-arid areas on the water resources. Example of Essaouira Basin (Morocco)

S. Ouhamdouch (1) ; M. Bahir (2) ; A. Souhel (3) ; M. Paula (4)

(1) Cadi Ayyad University, Geology, Marrakech, Morocco; (2) ENS Marrakech, Geology, Marrakech, Morocco; (3) ENS Marrakech, Geology, Marrakech, Morocco; (4) Universidade de Lisboa, Lisboa, Portugal

The Maghreb countries Algeria, Morocco and Tunisia are affected by the climate change, which is manifested by the tendency to increased temperatures and decreased rainfall. This has several negative effects on natural resources such as water resources. Among them: (i) The scarcity of water resources. (ii) The increased salinization of soils and, consequently, the salinity of waters. (iii) The drought, which leads to soil erosion, which causes the silting of the dam and, consequently, the decrease in the rate of mobilization. Overexploitation of coastal aquifers and pollution vulnerability are among the main problems related to groundwater resources assessment and management in arid and semi-arid regions threatened by desertification being the only source for agricultural and public water supply. The behavior of the aquifer system in the Essaouira basin (the object of our study) in the face of climate change, based on the interpretation of hydrochemical data (major elements), piezometric and isotopic (18O, 2H, 3H and 14C) was used to determine the degree of impact of climate change on aquifer system. The follow-up of the quality evolution of groundwater in the Essaouira Basin suggests a decrease in electrical conductivity and the chloride concentration showed that this quality is in close relationship with the vagaries of the weather. Changes in groundwater levels in the study area, brings up these levels would decline over the years to rainfall deficit and would renew or excess. The use of the techniques...
Impact of future global climate and land use and land cover changes in Amazonian run-of-river hydropower plants

J. Tomasella (1) ; D. Rodriguez (1) ; RRDCS. Von (1) ; GS. Mohor (1) ; JIL. Siqueira (1) ; LG. Lopes (1)
(1) INPE, CCST, Cachoeira Paulista/SP, Brazil

Brazilian strategic interest in Amazonia includes the development of hydropower to satisfy the country’s growing energy needs and new waterways to boost regional trade and economic development. Of the total amount invested in the Amazon until 2020, 37% will be allocated in the constructions of hydropower dams, which correspond to 45% of planned energy expansion during the period. Changes in land use and land-cover constraints, hydropower dams under construction in Amazonia are run-of-river (ROR) type plants, thus, with a limited storage reservoir to minimize the area of natural forest to be flooded. Although, ROR plants dramatically reduce environmental local impacts compared to traditional large dams, they are subject to seasonal river flows. Considering that the Amazon Basin is characterized by high interannual variability, and have been recently affected by the occurrence of extreme droughts (for instance, 2005 and 2010), it is clear that the generation capacity of ROR plant could potentially be seriously compromised by extreme events. Besides this, IPCC scenarios indicate that climate change can seriously impact the hydrological regime South American rivers, which might also affect the distribution of biomes in South America due to the synergistic combination of impacts due to both land cover (deforestation, forest fires and fragmentation) and global climate changes. Therefore, the aim of this study was to critically assess how different global climate change scenarios impact the Amazon Basin. We used regional climate change scenarios to assess how Amazonia could be affected by future climate change, and to the possible range of impacts on hydrology, hydropower generation and associated economic activities. To achieve this goal, we calibrated the MHD-INPE hydrological model for the period 1970–1990 using hydrological, meteorological and soil data from different sources from Brazil, Bolivia and Peru. We analyzed the ability of the model to simulate the present hydrological regime when climate model simulations were used as input. Climate change projections produced by different climate models were used in the hydrological model for assessing different scenarios with and without regional land-use and land-cover changes induced by forest conversion to pasture for the period from 2011–2099. Finally we assessed the impacts of climate change on hydropower generation based on the differences in the power duration curve – PDC produced by each scenario. The PDC of each scenario was estimated using hydraulic head and efficiency of each plant constrained by the minimum flow, under which the plant cannot operate, and the plant installed capacity. The use of PDCs allow to analyze the impacts not only of the annual average discharge, but also the effects of seasonal changes of climate. Despite of the differences among climate projections, results show that the climate change projections lead to a decreasing annual energy production and an increase in the load factor of hydropower plants. Even when it is not possible to conclude about which projected climate scenario is the more appropriated, this work suggest to assess climate change impacts on energy production through an exploratory analyses, evaluating the robustness of the plant design under several plausible scenarios.
Continental aquatic systems in Mexico exhibit a high vulnerability to climate change. In particular, variations in the patterns of precipitation and drought associated to climate change threatens both: a) the availability and quality of freshwater in the vast arid extension of the country (Northern Center Mexico) and b) the population and infrastructure in the Southern region of the country, were heavy rains cause severe flood events. Aquifer overexploitation is also a crescent problem, associated to a fast disappearance of the hydrological recharge to potential pollution in the karstic Yucatan peninsula, where groundwater is the only source of freshwater.

The effects of climate change on Mexican inland waters are mainly related to five processes: 1) changes in the water level of the systems and associated ecological impacts, 2) changes in the the physical structure and existent network of lakes and reservoirs, 3) increased trophic state and intensification of hypoxia, 4) eutrophication and toxic algal blooms, and 5) increased respiration that turns the the metabolic balance towards net heterotrophy. In particular, the processes implied in driving system shifts from sinks to sources of atmospheric carbon in tropical inland waters are discussed, although the data to build these analyses are still scarce and heterogeneous. We outline that research on tropical cyanobacteria metabolic treats may provide relevant elements to understand the increasingly threat of noxious phytoplankton blooms.

Here we highlight the research lines that need to be reinforced in order to create the strategies for preservation and management of freshwater in a sustainable way: 1) changes in the climate, hydrological and atmospheric fluxes, should be estimated in ecosystems to basin scales, and should be incorporated into long term studies of water quality, 2) pollutant assessment as well as water treatment processes (e.g. increase significantly (only 37% of the Mexican municipalities have water treatment plants), and 3) systematic monitoring programs should be included in country-scale planning.

Diverse social issues (e.g. inequity, corruption, security and drug dealing) threaten the possibility of coping with the challenges that climate change involve for continental aquatic systems in Mexico.

**Analysis of groundwater level historical data to detect climate change impact in France**

JF. Vernoux (1); JJ. Seguin (1)

(1) BRGM, Orleans, France

The level of groundwater bodies depends for many of them on the infiltration of meteoric water and will therefore be necessarily impacted by climate change if it causes a change in the infiltration system (intensity, period). To assess and monitor the impact of this change, a dedicated groundwater monitoring network is necessary. As this impact is currently unclear, the implementation of such a network involves an analysis of existing groundwater level data series.

The study was based on Mann–Kendall trend detection tests from groundwater level data and a comparison of tests between groundwater level data and climate data (precipitation, temperature, potential evapotranspiration). Trend detection tests were carried out on 377 piezometers of the French national groundwater quantitative monitoring network for which we had a data series of at least 25 years. In the end, 70 have a significant trend, 44 down and 26 up. Piezometers showing significant trend mostly concern aquifers with predominant annual hydrologic cycle. But most of them were in France. Fluctuations, aquifer weakly impacted by withdrawals, likely to be impacted by climate change, large piezometric fluctuations, aquifer weakly impacted by withdrawals, aquifer to preserve for the future. To select piezometers for each aquifer, the main criteria was a low anthropogenic impact.

**The Management of Traditional Hand Dug Wells**

ALD. Wamba (1)

(1) Association AFVMC – Aide aux Familles et Victimes des Migrations Clandestines, Administration, Douala, Littoral, Cameroon

The population of Cameroon is about 22 millions of inhabitants. The country has at least 1.20 billion m³ of usable groundwater resources unevenly distributed. The proportion of Cameroon’s population with access to clean water was estimated at 57.8 per cent in 2005. It was 40 per cent for rural areas. Groundwater Management provides information on the distribution of groundwater resources and the feasibility of the water supply technology through the building of traditional Hand Dug Wells (HDWs). Our objectives are to show how a successful management of HDWs is economically-viable for existing water supply and for the sustainable development of communities.

The methodology of fieldwork involves three stages: the decision to establish a new, or renovate and existing HDWs in the village, the construction/ installation of the HDWs and its management. The materials required: Guided interviews/seminars/workshops with key informers (officers of the administration and NGOs, builders of HDW’s technology, representatives of farmers and pastoral associations, professional diggers of HDWs, land committees, farmers and village chiefs).- Group discussions (focus groups to help identify key issues for field work and for the discussion of the preliminary results of research).

The analysis are:

The idea of common ownership of the HDW is a reality for more impactful stakeholders’ engagement:

1) In local municipalities:
   - the economical development of rural areas;
   - the availability of potable water for the population;
   - the reduction of water diseases;
   - the improvement of the hygiene and sanitation within the population;
   - the development of agriculture/irrigation/breeding

2) In associations of women interested in the management of HDWs:
   - the availability of potable water to reduce the burden of fetching water dedicated to women and children;
   - the improvement of the hygiene and sanitation in houses;
   - the development of agriculture/irrigation/breeding.

3) In associations of youth interested in the management of HDWs:
   - the learning of the duplication of the construction/management of Hand Dug Wells;
   - the sustainable development of the locality;
   - the availability of job opportunities in the construction/management of Hand Dug Wells.

The results are:
Glacier retreat from a regional point of view: Characterization of glacier area changes over the Southern Central Andes Region

N. Zazulie (1); E. Briche, (2); M. Rusticucci (3); GB. Raga, (4)
(1) University of Buenos Aires, Departament of Atmospheric and Oceanic Sciences, Buenos Aires, Argentina; (2) UNIMI--IAEICI 3351/CNRS--CONICET--UBA, Buenos Aires, Argentina; (3) University of Buenos Aires, Atmospheric and Ocean Sciences, Buenos Aires, Argentina; (4) Unidad Nacional Autónoma de Mexico, Centro de ciencias de la atmosfera, Mexico DF, Mexico

In the region known as the southern central Andes of Argentina and Chile (between 30° and 37°S), some of the highest peaks are found. Glaciers are present in the high Andes from which originate several of the main rivers that flow through Chile to the Pacific and through Argentina to the Atlantic. Because of the temperate climate in the foothills on both sides of the Andes, this region is inhabited by the majority of the Chilean population as well as the largest fraction of the population in western Argentina.

Changes are studied in terms of total glaciated areas and altitudinal and latitudinal dependence was explored. Every latitudinal band has shown different rates of changes which imply that environmental factors other than latitude may play key role in determining the difference in the observed changes. Furthermore, a number of glaciers were identified and studied as independent units which allows to consider other environmental factors, such as morphological characteristics of the different glaciers. As an example, the glacier Juncal del sur (33°06'S, 70°07'W) situated in the Aconcagua river basin near the metropolitarian area of Santiago de Chile has lost about 5% of its total area between 1989 and 2014. Another glacier with accumulation zone at similar altitude, the Maipo volcano glacier (34°09'S--69°48'W) has reduced its total area by less than 2% in the same period. Even though the glaciers are situated within the same region, the second glacier belongs to a protected area. These factors are key when analyzing different behaviors within the same region.

2212b - Climate change and freshwater - 2: Shaping the Future

ORAL PRESENTATIONS

K-2212b-01 Water security: Global challenges, global responses?
F. Berkhout (1)
(1) King’s College London, Geography, London, United Kingdom

Röckstrom et al. (2009) suggest using consumptive water run-off (or blue water use) as a proxy for global freshwater use. Assuming an upper limit of ~12 500–15 000 km3 year−1 would represent a significant risk to ecosystems, moisture feedbacks and freshwater/ocean mixing. Given that consumptive use is now at about 2600 km3 year−1 the authors conclude that there appears to be some room for manoeuvre, although there continues to be a trend of rapidly growing consumptive water use at the global scale. An Anthropocene or planetary boundaries framing of global sustainable development problems suggests a global governance of planetary boundaries. But there are questions about whether the planetary (or global) scale is really the appropriate scale at which to govern many of critical global resources and environmental services, including water. Water is typically governed at the level of the river basin and ecosystem. Moreover, while for some global environmental problems, like stratospheric ozone depletion, global governance appears to have been, in large part, successful, there are questions about whether such global coordination can be achieved in other cases. While global governance regimes now exist in many environmental domains, including climate change, achieving an alignment of interests leading to a common understanding of the problem and effective action at the global scale has often proven elusive. Water security emerges at many different and connected scales, from the local to the global. There are important legal, regulatory and voluntary dimensions of global water governance that contribute to water security across these scales. These include norms about rights to water, trade in virtual water, territorial and other state boundaries for water, as well as international transfers of knowledge, technology and finance to support water security. The paper argues that much of the task of governance will need to be focused on fostering transitions in water use, starting at the local level.

K-2212b-02 Shaping the future of freshwater: towards a collective effort to enhance our understanding and capacity to model change
H. Savenije (1); A. Montanari (2); C. Cudennec (3)
(1) IAHs, Delft Technical University, Delft, Netherlands; (2) IAHs, Bologna University, Bologna, Italy; (3) IAHs, Allenvi, Agrocampus Ouest, Rennes, France

A large part of the Earth surface may still be in pristine condition, but humans have already had significant impacts on many hydrological processes relevant to society.
Humans have changed the face of the Earth dramatically over the last few decades, in doing so introduced substantial changes in the water cycle. Climatic change is one of these impacts, but effects of land use change on: erosion, the character of floods, droughts, and the partitioning and distribution of moisture fluxes are often more noticeably at human scales. In fact, the limited transferability of water in space and time implies that water withdrawals from natural resources take place where and when water is needed, thereby causing a direct perturbation to all water bodies relevant to society, and therefore to society itself. The current trend of population dynamics and the current status of water systems are such that this impact will not be sustainable in the near future. Therefore mitigation actions are urgently needed, and planning thereof needs to be based on improved interpretations of the impact.

Until recently, hydrologists mainly concentrated on catchments where human perturbation was limited, so as not to understand the functioning of pristine hydrology. Nowadays, the urgency to mitigate the global water crisis through improved water management calls for research that attempts to bridge water and social sciences. To reach this target, new science is needed aimed at improved interpretation and modeling of the integrated human and water system. The question is how to build operational models that not only focus on the interactions among water systems and society. This scientific challenge and the ambition to improve freshwater management in a changing environment together with the need to ensure the sustainability of the science initiative «Panta Rhei», promoted by the International Association of Hydrological Sciences. Panta Rhei focuses on three targets, namely: to improve understanding; to enhance predictive capabilities; and to support societal water planning. Hence since its inception, Panta Rhei already counts 30 working groups, involving about 300 scientists, who are developing innovative theories and modeling approaches to address the above interconnections. By doing so, Panta Rhei is catalyzing a collective effort to assist societies to mitigate the global water crisis.

Prospective approach for assessing change in water resources management for large river basins in France

E. Sauquet (1); Y. Arama (2); E. Blanc-Couistique (3); H. Bocart (2); F. Branger (1); L. Braud (1); JF. Brun (3); A. Duche (4); F. Hendrickx (5); B. Hingray (6); F. Krowicki (7); M. Le Lay (8); F. Malerbe (3); C. Monteil (5); C. Perrin (9); R. Samie (5); A. Rossi (7); P. Strosser (7); G. Thirel (9); JP. Vidal (1)

Water management planning is influenced by many natural and human factors that interact at basin scale. A multidisciplinary approach is therefore required to both understand and well represent the main characteristics of the water system before analysing its sustainability under global change and suggesting efficient adaptation measures. The complexity of the interactions and thus the challenge in modelling increase with the size of the river basin. This talk presents the main results of the research project R2D2-2050 “Risk, water Resources and sustainable management of the Durance river basin in 2050” (Sauquet et al., 2014). The Durance River, one of the major rivers located in the Southern part of the French Alps, supplies water for competing human uses (irrigation, hydropower, drinking water, industries and more resources tourism and ecological services) within and out of the drainage area through an extended open channel network. The project R2D2-2050 aimed to assess impact of global changes on current water management – especially operating rules for the three main reservoirs – would need changing under future conditions taking into account evolutions in both climatic and socio-economic dynamics. The model approach was carried out to simulate regional climate, water resources, irrigation needs, water supply for domestic purposes, water transfers and reservoir operations. A model of water management similar to the operational tool used by the French hydropower producer EDM was also developed to simulate water released from the reservoirs on present-day conditions under constraints imposed by ecological flows and water levels in summer for recreational purposes.
are being monitored for precipitation and stream flow in 9 sites located in Venezuela, Ecuador, Peru, and Bolivia. The sites are supported by local stakeholders and communities in a participatory approach that otherwise would be impractical or prohibitively expensive.

Because of the technical challenges of monitoring hydrological variables in remote mountain areas, we set up a web-based infrastructure to support local technicians and stakeholders. Additionally, using open data standards such as those of the Open Geospatial Consortium, the data can be pooled efficiently for regional-scale analysis, as well as processed and visualized efficiently. Lastly, the datasets can be coupled to web-based hydrological models using rich and interactive interfaces. Such setups, which we refer to as “environmental virtual observatories”, can support water and land users at different scales of decision-making, from community level to national governance entities, and at different levels of technical and scientific skills.

In our presentation, we will report on the effort of setting up a citizen science approach to monitoring freshwater resources in the tropical Andes, and how this can be used to support local management efforts. We will show our successes, as well as the remaining challenges in the technological, hydrological, and social science domains.

O-2212b-02
Science-policy interface to foster scientific development and uptake by policy makers for the purpose of water management in the context of climate change and climate change adaptation strategies development

F. Martini (1)
(1) Onema, Vincennes, France

Water resources challenges exacerbated by global change including climate variability can affect water security and human well-being. To globally face this situation, there is a need to develop evidence-based policy incorporating accurate information related to predicted global changes.

But water and climate change research outputs are insufficient reaching water managers today. And there’s a lack of places where water managers can express the scientific information they need to develop their adaptation strategies.

A science–policy interface (SPI) answers this challenge by enhancing science–based policy development and fostering dialogue between researchers and water managers to better address the expression of policy requirements of scientific knowledge for specific management decisions, and a common understanding of these needs. It identifies existing scientific knowledge fulfilling specific ongoing and future interests. Development of research agendas to match future policy needs. It finally allows a mutual understanding and long–lasting dialogue between scientists and policy makers.

Three science–policy interface experiences studied at international, European and national levels led to identify some recommendations to set a sustainable science–policy interface helping to face the challenges of water and climate change.

The 6th World water forum recommended initiating an international networking platform for researchers and water managers in order to facilitate communications in relation to the IPCC and other UN conventions. The objective of which is to provide relevant scientific inputs to help governments and water managers develop effective decisions and climate change adaptation strategies, considering the uncertainty related to the impact of climate change on water resources. A mapping of existing SPI mechanisms over the world initiated this investigation.

From 2010 to 2012 a science–policy interface for the water framework directive (WFD) has been operated by the European commission and France. This SPI intended to support WFD implementation by helping provide and if needed produce adequate scientific information.

With a view to improving the uptake of science by policy makers involved in water management decisions in the context of climate change, and conversely the comprehension by scientists of the needs of policy makers, Onema organized on 3 February 2015 a seminar of scientists and policy makers. This event allowed them to share their knowledge and views on scientific needs, and raise recommendations on science–policy dialogue enhancement.

Those three experiences led to consolidate some main principles to set and maintain a science–policy interface which allows a better science-based water policy development under climate change.

Establish a sustainable Community of practices (CoP). The CoP is a consistent group of stakeholders of the water sector: scientists, water managers, knowledge brokers, politicians, journalists, civil society, ensuring a multidisciplinary approach. It should engage stakeholders from all the scales of the water management (and around the world). It ensures the operating of the SPI.

Appoint Knowledge Brokers and form them. They are skilled experts dedicated, trained, and resourced to engage in the SPI. They assist policy makers in formulating scientific and technical questions, enhance the scientific knowledge transfer to the policy makers and contribute to keep research aligned with policy needs.

Improve Communication and Tools. Communication may be encouraged and improved at all levels through the creation of a platform in which the CoP can share information and network. Recent research findings and request for collaborators with particular expertise for future research projects can be shared. Then policy makers can have access scientific information digested into policy briefs and other publications, seek experts’ scientific opinion, and communicate their research needs to scientists.

O-2212b-03
“Water crisis and tensions in Europe and in the Mediterranean by 2050: future scenarios?”

MA. Martin (1); S. Fernandez (2); M. Lang (3); J. Verdier (4); PL. Violelt (5)
(1) Académie de l’Eau, Water management, Paris, France; (2) IRSA, UMR geste, Strasbourg, France; (3) IRSTEA – Lyon, France; (4) AFEID, Montpellier, France; (5) AFN, Paris, France

All around the world, water resources management is facing numerous challenges. The predicted effects of greenhouse gas emissions are of particular concern with regard to future droughts, which frequency and intensity are expected to increase. Despite the many uncertainties reflected in various future studies conducted in France, a general trend of decline emerges in the long term (2050–2070) with a 10 to 40 % decrease of the annual average river flows. Due to the decrease in snow to surface, the regime could also evolve from a nival (snowmelt dominated) regime to a pluvial (rainfall) regime, with lower flows during the summer – when crop evapotranspiration is at its maximum. Studies carried on aquifers, suggest, under a business–as–usual scenario, an acceleration and intensification of the level of exploitation or of the degradation of the quality of many of them. Challenges and risks are particularly high in the Mediterranean between with a tendency towards an increased concentration of their population along coasts or within deltas, having direct and significant implications for drinking water supply and sanitation.

Foresight studies on water – related issues. The issue of scale is usually not discussed as such when conducting foresight studies. The watershed is certainly a relevant unit for surface hydrology. It does not, however, necessarily allow grasping groundwater, nor the territorial basis upon which public action is deployed. Greater emphasis should also be given to other scales such as water supply and water demands. On one hand, quantification is important in order to ensure the consistency of a given scenario, but must be done at a later stage. On the other hand, possible disruptions are difficult to model. Their probability of occurrence can certainly be quite well modeled, as long as a wide range of temporal uncertainty is acknowledged. What happens after any type of disruption is, instead, often qualitatively and quantitatively unpredictable.

Issues related to the status of global change, Climate
change is usually represented as a ‘driving force’ of the system at stake, that legitimizes foresight debates, since it should lead to a decrease of water resources (on an annual or seasonal average), that could be very intense locally, and to a greater variability of the resource in space and time. While the water-climate nexus was brought to the international political agenda, the concept of adaptation also emerged, a concept to be differentiated from mitigation. Water issues are also to be framed in terms of adaptation, while having in mind that mitigation measures can significantly reduce adaptation costs.

Future issues. In Europe and in the Mediterranean basin, major issues are related to future tensions over water resources management and to likely induced disruptions. Possible answers to this should take into account the relations between climate change and the evolution of water uses, at an adequate time horizon (2050); it should also integrate hydrological and climate studies as well as social sciences approaches or results. Such is the aim of the international conference «Water Tensions in Europe and in the Mediterranean basin: freshwaters» by 2050? organized by SHF, AFEID, the Water Academy and UiSF, to be held at Paris (7–9 October 2015). Three cardinal themes have been identified: 1/ Analysis of past and present ‘crises’ and tensions on water resources. How, by whom and when, these past events have been classified as ‘crises’ of ‘tensions’…? How were they governed, evaluated, entertained? How these analyses help in imagining the future? 2/ Forecast of the evolution of surface water and groundwater regime by 2050, and consequences associated in terms of water scarcity and water equitable use. The nature of uncertainty linked to the identified spatial scales shall be studied as well. 3/ Methodological issues for prospective studies. How to build relevant analysis scales in prospective studies, how to relate the socio-economic drivers and the climate evolution, and clarify uncertainties related to prospective studies and how to make more explicit the social and political dimensions that are inherent to prospective analysis? How to tackle water crises and their consequences? What kind of ruptures are to be considered? What can be expected from “new” technologies?

The importance of protecting and restore freshwater ecosystems for sustainable development and building resilience to climate change

S. Widfors (1); K. Lexen (2)
(1) Stockholm International Water Institute, International Processes, Stockholm, Sweden; (2) Stockholm International Water Institute, World water week & international processes, Stockholm, Sweden

According to OECD (2012), the global demand for freshwater is projected to increase by 55% between 2000 and 2050. Freshwater ecosystems such as wetlands, lakes and peatlands are the most essential of ecosystem services providing for food security, income, health and resilience to climate change induced impacts. Safely managed water resources are necessary for human wellbeing, for protecting communities from climate induced vulnerability and for sustainable development (UN Water 2014; UNFCC climate strategy Assessment 2005). Stress on already exposed water resources has implications on local communities relying on the sources for their human security and livelihood, it will impair the ability to overcome inequalities and enhance economic development (UN Water 2014). Women are at a higher risk of being negatively affected by hydro-climatic disasters, and to the exposure of water- and sanitation related diseases. Freshwater interlinks sustainable development strategies with effective mitigation action. Wisely managed water strengthens climate adaptation capacities and protects livelihoods. Freshwater ecosystems harness the potential for reduced climate vulnerability, while being vital for resilient, prosperous communities, and this should be acknowledged in global policies. Further, bridging the gap between policy and practice, facilitating the integration and application of local experiences from indigenous communities, is necessary in order to build relevant capacity.

Climatic Change in the Amazon Estuary: perception of changes and impact on production by traditional population

O. Almeida (1); S. Rivero, (2); N. Vogt, (3); CM. Alvez-Valle, (4); Y. Dou, (5); S. Thomas (1); N. Moreira, (6); A. Saldanhna, (7); V. Zeidemann (8)
(1) UFPA, NAEA, Belem PA, Brazil; (2) UFPA, Economics, Belem PA, Brazil; (3) INPE, Sao Jose dos Campos, Brazil; (4) UFJF, Ecology, Juiz de Fora University, Geography, Waterloo, Canada; (6) IFPA, Aqulatic, Belem PA, Brazil; (7) Emater, Pesca, Belem PA, Brazil; (8) Federal University of Pará, Economic Graduation Program, Belém, Pará, Brazil

The studies on climate change in Amazonia have focused on the impact of changes on the regional climate (Coe et al., 2002, Costa et al., 2013, Costa et al, 2007, Sampaio et al., 2007, Oliveira et al 2013) or on the relationship of climate change and reduction of biomass (Phillips et al. 2013) and more recently on the interactions between human activities (such as deforestation), climate change and the water system (Melack et al. 2013). This paper aims to analyze the perception of traditional estuarine population in relation to climatic change and its consequences, and how the potential for adaptation to climate change in this population. A semi-structured questionnaire was applied with 239 families in two communities in the municipality of Alto Pará, Aetaetuba. Perceptions of climate impacts vary according to the activity and the type of weather event to be evaluated. In general the product dries on the tree or fall and, according to the interviewees, can reduce yields by up to 46%. Weather event to be evaluated, the fishing activity the answers were not as uniform as for the acá. In general, 54–58% report that high temperature affects the shrimp and fish (respectively) reducing their catch. The shrimp seem to be more susceptible to temperature increases and most of the informants said that the reduction occurs in the range 10–20% of production. The perception that temperature affects fishing fish is low (23% of total). The importance of rain, however, was remarkable for fishing. Most of the respondents say that increased rainfall and reduces fish and shrimp production (78% and 81%, respectively). In this case, around 50% said that production is reduced between 10–20% while 20% say that the reduction is around 50%. The tide seems to have huge impact on fisheries. In this case, the respondents said that when the tides were higher there was a large reduction in fish and shrimp production (22% and 12%, respectively). Surprisingly while 65% of respondents said that there was no way to reduce the impact of high temperatures on shrimp farming and fishing, the rest (45%), for the most part benefit, believed that reductions would be a way to alleviate the impact. The population of the estuary is subject to a continuous process of adaptation. The cycle of sugarcane mills encouraged the planting of sugar cane from 1920 to 1987 (Andersson 1991) resulting in deforestation of lowland forest. In 1987 in the end of the cycle, the population began the cycle of palm hearts, cutting down much of the native palm heart trees and finally with the rising price of açai fruit they began a process or maintenance of forest with enrichment of açai trees or reforesting açai trees in areas previously cleared. In 1984 with the construction of Tucurui hydroelectric dam, there were huge drop in fish catch (Luras et al., 2007) downstream of the dam to which the population also had to adapt. These experiences resulted in a higher capacity of adaptation by local population. The issues won the governments and the limitations of possible activities in the várzea and the high dependence on fishing and açai this population need to be aware of the impacts.
atmosphere have increased because of anthropogenic activities, but information on their emissions are still scattered in the scientific community. Hydroelectric dams have become the subject of speculation that their reservoirs are totally relevant. Research conducted primarily by COPPE / UFRJ in Brazil have shown that these systems have emissions of particular concern: CO2 and CH4. However, studies show that depending on the construction, operation, climate, soil and wetland biome type, hydropower reservoirs emit less or similar to various natural environments (wetlands, rivers, lakes, estuaries, etc.) are essential so that we can have a review of this issue and improve our understanding. However, in 2012 it had no information about the existence of a database with this focus. As a result, the IVIC/COPPE from Brazil created WebRESNAT (http://webresnat.ivig.coppe.ufrj.br), an online map with which people can access information about greenhouse gas emissions (CH4 and CO2) in hydroelectric reservoirs and natural aquatic environments worldwide. The study consisted of developing a data system based on GIS (Geographic Information Systems), whose objective was to collect, develop and disseminate information to assist in the analysis of the GHG and various geo-environmental parameters in hydroelectric reservoirs and natural environments through an online portal. The next steps will be oriented to the expansion, refinement and further details of the portal, using interactive maps that allow the user to view different aspects of specific areas, and that in question. With your interest, the different scales and varying degrees of detail. After its development, will become a very useful tool for the research community, because with it you can promote interactions, intercomparisons, collaborations and joint analyzes.

P-2212b-03

Integrated Modeling in support of Trans-boundary Water Cooperation in Central Asia: Ili-Balkhash watershed

A. Baubekova (1)
(1) Industrial Trading Group, Ecology, Astana, Kazakhstan

There is a concern that the Lake Balkhash can repeat the fate of the Aral Sea. Balkhash is the second largest lake in Central Asia and it has environmental, social and economic value. For 10 years the loss of this lake will lead to deterioration of the climate change consequences in the region. An increase of the average air temperature by 1.3°C during the century that country is already facing is two times higher than the global warming value. This will be in massive desertification and soil degradation, which will negatively impact on economy and living conditions in the region.

In order to verify this assertion an integrated model of the transboundary Ili – Balkhash watershed was done. Climate change and socio-economic changes were assessed for the level of influence on the lake system. Climate Change analysis was processed in Astana with the support of Laboratory of Energy, Ecology and Climate of Nazarbayev University Research and Innovation System. A Bayesian statistical framework was used in order to make probabilistic forecast of climate change in the regional scale (Tebaldi et al. 2005). The analysis of socio-economic changes was based on the use of GIS techniques and remote sensing as well as interview review. Nine climate scenarios were developed including climatic, economic and combined sets. An initial scenario showed that the Lake Balkhash is already affected by climate change, its level is unstable. This scenario or 4.5 scenario that provided favorable conditions for the water regime has showed the only positive result and increase of water level. But this scenario is not realistic as finding out, that the high indicated forcing. Environmental flows will increase the interest for such a kind of aquifers due to their strong infiltration and storage capacity, in a broad context of higher water scarcity.

The Lez and the Lison karst systems in Southern and Eastern France, respectively, provide 2 examples of such systems of the several karst. Under two contrasted climate conditions, the first one being heavily exploited. This study presents a comparative climate change assessment on both karst systems. Nine climate scenarios corresponding to a Fourth assessment report of the IPCC (SRES A1f scenario), downscaled using weather–type methods by the CERFACS, have been applied to various recharge modelling approaches, as standard analytical solutions of recharge estimation and soil–water balance models. Results are compared and discussed in order to assess the influence on climate change impacts of i) the climate conditions (geographic location), ii) the groundwater exploitation and iii) the modelling approach.

P-2212b-05

Balancing water uses and availability under human- and climate-induced changes at the 2050 horizon

J. Fabre (1) ; D. Ruellan (1) ; A. Dezetter, (2) ; B. Grouillet, (1)
(1) CNRS, HydroSciences Montpellier, Montpellier, France; (2) IRD, Hydrosciences montpellier, Montpellier, France

Over the past decades, human and climatic pressures on water resources have been increasing in the Mediterranean region and the area could experience higher water stress over the 21st century. This study aims to assess water stress by 2050 in Mediterranean river basins facing increasing human and climatic pressures, and to compare the impacts of a wide range of possible future socio-economic and climate trends.

A modeling framework integrating human and hydro-climatic dynamics and accounting for interactions between resource and demand at a 10–day time step was developed and applied in two basins of different scales and with contrasted water uses: the Herault (2 500 km², France) and the Ebro (85 000 km², Spain) basins. Natural streamflow was evaluated using a conceptual hydrological model. A demand–driven reservoir management model was designed to account for streamflow regulations from the main dams. Urban water demand was estimated from time series of population and monthly unit water consumption data. Agricultural water demand was computed from time series of irrigated area, crop and soil data, and climate forcing. Environmental flows were accounted for by defining streamflow thresholds under which withdrawals were strictly limited. Indicators comparing water supply to demand at strategic resource and demand nodes were selected, calibrated and validated under non–stationary human and hydro–climatic conditions over the last 40 years before being applied under four combinations of water use and climatic scenarios to differentiate the impacts of human- and climate-induced changes on streamflow and water
Climate simulations from the CMIP5 exercise were used to generate 18 climate scenarios at the 2050 horizon (from nine climate models and two Representative Concentration Pathways). Two water use scenarios were considered: water uses of the 2000s and a trend water use scenario at the 2050 horizon, based on demographic and local socio-economic trends. The sensitivity of water stress to variations in the main drivers of water demand and availability under the trend water use and climate change scenarios was tested to assess the efficiency of potential adaptation measures.

Temperature projections show a clear increasing trend, particularly marked in the summer. Projections for precipitation are more uncertain and differ among the 18 scenarios considered. However, a decrease in spring and summer precipitation is expected in both basins. The climate change trends result in changes in discharge: while scenarios diverge in fall, winter and spring, all 18 scenarios result in a decrease in summer low flows. Simulations revealed a significant increase in total water demand over the temperature and climate change scenarios in 2050 in both basins. Results also show that projected water uses are not sustainable under climate change scenarios. While anthropogenic drivers could influence variations in water demand more than climate change, in the Herault basin the impact of climate change could be more determining than water use changes for the balance between water available and water useful. Some of the ebro basin water use changes could have a larger impact than climate change on water stress. The combination of the trend water use scenario and climate change scenarios could also have a high impact on respect of the environmental flows in both basins. Finally, water stress showed little sensitivity to individual variations in the drivers of water demand.

This study points out the areas most vulnerable to human- and/or climate-induced changes by 2050 in two Mediterranean basins. In both basins a combination of adaptation measures leading to a large decrease in water demand and an optimized management of water availability will be necessary in order to supply enough water to satisfy demand while limiting anthropogenic pressure on water resources to sustainable levels.

Revising the planetary boundary for freshwater use

D. Gerten (1); J. Heinke, (1); A. Pastor (2); J. Jägermeyr (1)
(1) Potsdam Institute for Climate Impact Research, Potsdam, Germany; (2) Wageningen University, Wageningen, Netherlands

The nine planetary boundaries represent thresholds for key earth system processes which, if crossed due to collective and anthropogenic activities, may push the earth system towards a Holocene status with potentially desastrous consequences for human societies. While the concept and quantitative basis of planetary boundaries has recently undergone a comprehensive update (Rockstrom et al., 2017), some boundaries still require a more robust quantification, especially in terms of the upscaling of regional patterns to the planetary scale.

This presentation shows a way to improve the assessment of the planetary boundary for human freshwater use, and the proximity to this boundary given current and potential future water demand and use. Our core concept is to account for the environmental flow requirements of riverine ecosystems as local limitations to human water use, which serve as a basis for a geographically explicit "bottom-up" estimation of the planetary boundary. Our pilot assessment indicates that respecting the environmental flow requirements yields a planetary boundary value that is potentially lower than suggested earlier. Different estimation methods and datasets (e.g., river flow assessments, river flow measurements, climate simulations, ecological flow requirements) are already exceeded in many places, such as in parts of southern Europe, southern Asia, the Near and Middle East, and in the western USA. Our assessment is based primarily on high-resolution simulations with a dynamic global vegetation and water balance model, LPJ-GUESS. Building upon these results, the presentation also elaborates on how the definition and quantification of the freshwater boundary both with respect to the management of the water system by including "green" water contributions, process linkages with the planetary boundary for land-system change, and also water ethical considerations.

“Garonne 2050”: an innovative participatory prospective study on the base of a strategy of adaptation to global changes for the Garonne river basin

F. Goulard (1)
(1) Agence de l’eau Adour-Garonne, Toulouse, France

With its “Garonne 2050” study, the Adour–Garonne Water Agency, which covers the south-west quarter of France, carried out a forward-looking analysis of needs and resources, primarily taking into account the impact of climatic change. Although there remain considerable uncertainties about precipitation, by 2050, raising temperatures would result in a substantial increase in evapotranspiration in this region, which means less available water.

The study took place over a period of three years (2010 to 2013) combining a forward-looking methodology with the participation of the stakeholders (mainly water users) and simulations used to calculate the approximate amounts of water to be mobilised and costs involved for the agency managing the river basin.

The principal challenge for 2050 is that natural flow will be halved during the low-water period which itself will be earlier and longer (May to November). At the heart of possible scenarios for adapting to such changes, the key factor is the societal choice that will be made in response to the two-pronged question: what flow of water do we want in our rivers in the summer? And what are we able to do about it? Thus, the result of the simulation indicated that if we wanted, by 2050, to compensate for this natural hydrological reduction to maintain today’s Target Low Water Flows (DOe) and preserve uses, biodiversity, aquatic recreational activities and landscapes during the summer period, then the total deficit, to be made good over the year, is around 760 Mm3/year (or to be more precise, a value between 480 and 1,200 Mm3 given uncertainties). As a comparison, summer surface water usage for irrigated agriculture in this basin currently amounts to around 400 Mm3 and water stored in hydroelectric reserves in this same area amounts to 1,200 Mm3.

Models of five initial exploratory scenarios were created and submitted for consultation. In this way, it was possible to reduce the scope of the strategic debate to three main water management scenarios.

One of the important conclusions of this study is that in a region that is both highly agricultural and attractive from a demographic point of view, it will be extremely difficult to secure uses and maintain a low-water flow as it is today with the natural hydrological context of the future.

However, without impacting the management of energy or completely sacrificing an activity like irrigated agriculture, it is almost impossible to maintain an acceptable low–water flow, without relying on additional storage. Other problems connected with the question of the water resource have not been sufficiently detailed in this study, which may lead to an under-estimation of the tensions at stake and the problems to come. These include pollution, of course, but also soil erosion and effects on biodiversity, river morphology and so on; all essential factors impacted and impacting the volumes of water available for various uses. Finally, since the study did not specifically look into implications and management of the water resource, an essential asset of a region of over 65,000 km2 which will accommodate over 5 million inhabitants in 2050.
Combined effect of climate change and groundwater abstraction on multi-layer alluvial aquifers in France

F. Habets (1); P. Viennot (2); C. Thierion (3); JP. Vergnes (4); A. Ait-Kaci (5); Y. Caballero (6); P. Ackerer (7); N. Amraoui (8); B. Augeard (9); F. Besson (10); JR. De Dreuzy (11); L. Longuevergne (12); E. Martin (13); T. Morel (14); F. Regimbeau (15); D. Thiery (15); JM. Soubeyroux (16)

ABSTRACT BOOK

Although nowadays groundwater resources are mostly affected by increasing water abstraction, they will have to face the impact of climate change. Even in a temperate climate as the one in northern France these two drivers will have strong impact on the aquifers. Evolution of groundwater resource is most often studied based on evolution of the rainfall infiltration that is assumed to be the aquifer recharge, although river–aquifer and multi-layer aquifer exchanges are also part of the recharge and can only be estimated using a hydrogeological model. Moreover using a change of the piezometric levels below the usually not found to be meaningful by stakeholder as a 1 meter variation can have different impact depending on the hydrogeological context. Therefore, in this study, to provide greater insight into the impact of groundwater, two new indicators are used: the evolution of the extension of groundwater-fed wetlands and the frequency with which a crisis piezometric head is exceeded. The crisis piezometric levels are used locally by stakeholders and as soon as the observed piezometric heads fall below these levels, actions are taken to preserve the water resource.

For the present study, the local crisis piezometric heads were extended to the whole studied basins, the Seine and Upper Rhine Graben basins.

The results show that the two basins under study are not affected in the same way by climate and groundwater abstraction changes. The Seine multi-layer aquifers are projected to suffer from a substantial decrease in rainfall infiltration (about 20%), while the decrease is lower in the Upper Rhine Graben aquifer (about 6%).

In 2050, the extension of groundwater-fed wetlands is expected to lose about 900m²/km², while the crisis piezometric heads are expected to be exceeded about 40% and 26% of the time on average on the Seine and Upper Rhine Graben aquifers, respectively. The reduction of the groundwater abstraction has a large impact locally but is not efficient enough to overcome the impact of climate change, although the impact is more sensitive on the Upper Rhine Graben than on the Seine, and particularly on the extension of wetlands and low flow. Sensitivity to the parameters that drive the river–aquifer exchange was found to be second order compared to the uncertainty due to the climate model in the Upper Rhine Graben, although these parameters have a considerable impact on present-day ecosystem services. The two new indicators are found to be highly useful to discuss the impact of climate change on groundwater with stakeholders.

In order to be able to extend such studies to the whole aquifers of France, and to have a survey of such impact as soon as new downscaled projections are available, the AquiFR project is bringing together hydrogeological applications used by stakeholder in a common platform that will be based at Météo-France.

Monitoring and Evaluation of Water Quality of Taal lake, Philippines

F. Martinez (1); I. Galera, (2)

P-2212b-09

Integrated Climate and Land Use Change on Downstream Ecosystem Service in the Ta Chin River Basin, Thailand

S. Monprapussorn (1)

P-2212b-10

Ecosystem provides goods and services that sustain all life on planet earth. The services provided by ecosystem and their components are highly crucial for human well-being such as providing of food, water, and habitat, regulating carbon sequestration and providing recreational resources. Economies and livelihoods in developing countries heavily depend on ecosystem service. Climate change is expected to be major cause for changing in ecosystem services in variety of ways. Land–use and land–cover change (LULCC) involves several processes that are central to the estimation of climate change and its impact on ecosystem. It is, therefore, very important that integrated climate and LULCC change framework scenarios will enhance the current and future knowledge of ecosystem services. The aim of the study is located in downstream portions of the Ta Chin river basin where the river Ta Chin passes through the heart of province and flows into gulf of Thailand. It consists of many tributaries networks which connecting the ecosystem of lands and seas make it as a suitable place for fishery and aquaculture.

This paper aims at exploring potential impact of climate and LULCC change on ecosystem services in downstream areas of the river basin. Three Land-use change scenarios were developed; business as usual scenarios (BAU), high economic growth (HEG) and green growth (GG) scenarios and integrated to different climate change scenarios (RCP 4.5 and RCP 6.0). For a case study, downstream ecosystem service in a changing climate and LULCC will be quantified baseline and projected change in provisioning of habitat and water supply. The interaction of socioeconomic development and climate change on runoff, streamflow and precipitation will be studied. The scenarios shows that habitat loss is expected to occur in a basin in according to urban/ residential sprawl (HGG scenario). Projection also reveals the increase in extreme precipitation in rainy season that may dominate runoff than recharge. Altered service of ecosystem leads to substantial effect on local livelihood. The results found that integrate climate smart land–use planning needs to be taken into consideration. It will reduce vulnerability and increase more efficient in water resource planning and resilience of local communities.
Salinity intrusion in the Mekong delta of Vietnam: Challenges and Solutions
H. Nguyen (1); S. Tyler, (1)
(1) Institute for Social and Environmental Transition – Vietnam, Hanoi, Vietnam

Mekong delta is located in the South of Vietnam, where salinity intrusion has been observed for many decades (Nguyen et al., 1999). As with many deltas, the Mekong delta is influenced by both river floods and tidal inflows. Before 1980, salinity impacted 1.7–2.1 million ha of a total 3.5 million ha of agricultural areas of the Mekong delta every two months during the dry season. In the 1980s and 1990s, a number of salinity control projects were implemented, including the construction of closure dams and sluice gates in the navigation channels connecting the branches of the delta. However, fresh water intakes along key estuary branches are affected each year by high salinity (Nguyen, 1999; Le A. T., 2006; Chu, T. H., 2012). As a result, these intakes have to be closed for anywhere from a few weeks to two months each year to prevent salt intrusion. (Nguyen and Savenjiev, 2006; Chu, T. H., 2012).

In recent years, stronger ocean tides and saline intrusion as a result of sea level rise are changing Mekong river flow in the dry season. Saline intrusion has started to influence river water near Can Tho city which is 65 km from the costal line and it impact to almost of sectors such as agriculture, aquaculture, infrastructure, water supply and local livelihood (ISET, 2013). According to the climate change scenario of the Ministry of Environment and Natural resource of Vietnam, the Mekong delta will be impacted significantly by sea level rise and salinity intrusion on the landscape (VNRE, 2012). The Mekong delta salinity of measured saline intrusion to the cities and provinces in the Mekong delta and the vulnerability of residents to that intrusion have made this an issue of concern for people in the region. The combination of land subsidence, sea level rise, upstream dams and extractions, and tidal flows are projected to produce rapidly increasing salinity levels. With an unusually high reliance on surface water for industrial, residential, and agricultural use, the inhabitants of the delta quickly recognized the need to respond to the situation. To further complicate matters, daily fluctuations provided a strong impetus to monitor levels as could provide real-time data to ensure that citizens, water utilities, public health agencies, farmers, and local industries were informed.

This paper introduces a new model of real-time salinity monitoring system, which has been installed, and maintaining in the Mekong delta. Without the ability to halt the salinization process, the paper presented a strong example of resilience planning. It enabled adaptive management at a household and institutional level. It brought multiple stakeholders together, including city authorities, national departments within government, and also involved collaboration with telephone companies to deliver SMS alerts. In addition, it focused on a pressing, but not immediate challenge, a category for which it’s difficult to generate interest or commitment. This paper also reviews scientific information related to salinity intrusion as well as the perspectives of scientists, key local stakeholders, and local communities in order to assess the likelihood for salinity intrusion in the Mekong delta and, based on that, review possible options for the next steps of planning and decision making.

Impacts of climate change in the Bolivian Altiplano
PL. Pacheco Mollinedo (1); AL. Gonzales Carrasco (2); J. Molina (3) ; A. Veizaga (1)
(1) Agua Sustentable, Climate Change Adaptation, La Paz, Bolivia; (2) Agua Sustentable, Climate change, La Paz, Bolivia; (3) Universidad Mayor de San Andrés, Instituto de hidrología e hidraulica, La Paz, Bolivia

Introduction
The biggest impacts of global climate change will be felt most in developing countries, specifically smallholder farmers like in the case of the Bolivian Altiplano. The vulnerability of the people living in the Bolivian Altiplano comes in various ways; one is the location, the high altitude given semi-arid climatic conditions and the recurrence of ENSO natural phenomena.

The impacts of climate change on water resources in the Altiplano will have consequences on the availability of the resource and its growing demand to meet water requirements of drinking water and irrigation for agriculture.

The focus of the study is the Mauri and Desaguadero river basin, located in the Bolivian highlands part of the binational (Bolivia–Peru) TDPS hydrological system (Titicaca, Desaguadero, Poompó and Colpasa salt lake). The Mauri and Desaguadero rivers provide irrigation water to more than 24,000 ha. of crops.

The aim of this study is to assess the impact of climate change on the historical availability and requirements of water in a basin of the Bolivian Altiplano as a base line to build future scenarios to construct a participatory integrated adaptation Plan for the basin.

Methods
For this topic, three specific studies (water availability, water rights and water requirements) are considered combining field work with participation of stakeholders in the area and office work to process the data acquired.

Water availability
This procedure implies the collection and process of hydrological data (1965–2012), defining the curves of discharge of hydrometric stations in the basins Mauri – Desaguadero and Lake Titicaca, and obtaining series of daily flows, monthly averages and annual averages validated.

Water Rights
To have a view of the local management of water in the basin, a mapping rights study was developed, it allows to spatially visualize the water rights in relation with the customary rules applied to the social organizations of users. The methodology consists on interviews to stakeholders, workshops with communities and processing work. The most important tool is the GIS to process information (Villarroel et al., 2014). Water requirements
The water requirements methodology for crops and wetlands begins with the collection of productive information, weather information and the information about social management of water.

The main irrigated crops in the area are alfalfa (Medicago sativa), potato (Solanum tuborsum), barley (Hordeum vulgare), oats (Avena sativa), wheat (Triticum aestivum), native grasses, introduced grasses and quinoa (Chenopodium quinoa). A considerable area of wetlands is also important for the requirements in the basin.

Results and discussions
A hydrological database (1965–2012) of 21 stations located throughout the TDPS system was generated to use it in flow calculation. The results in the model showed that during the period 1951 – 2012 a significant reduction of the annual average flow is observed for the station in the Mauri and Desaguadero Rivers. The reduction on the average flow of the Desaguadero river is caused by the contributions of Titicaca Lake, rainfall reduction and increased water usage in the upper side of the watershed (Molina et. Al. 2014).

The common law is that, in practice, grants, regulates and guarantees the rights of access to water for the residents of the area. Likewise, customary law is backed by positive law in different standards starting with the new Constitution of Bolivia that recognizes the habits and customs in water management.

After looking at the results of this study, it is important to consider that if the availability of water decreases and the water requirements increases, a deficit of water will be a fact.

Influences of Climate Change on Freshwater Resources Availability in a Basin Located in Asian Monsoon Region
W. Sun (1); J. Yu, (1)
(1) Beijing Normal University, College of Water Sciences, Beijing, China
The influences of climate change on fresh water resources availability in Chinese Jinjiang Basin located in Asian monsoon region were assessed using the Block-wise use of the TOPModel with the Muskingum–Cunge routing method (BTOPMC) distributed hydrological model. The ensemble average of downscaled output from sixteen GCMs (General Circulation Models) for the medium CO2 emission scenario in the 2050s was adopted to build regional climate change scenario. The projected precipitation and temperature data were used to drive BTOPMC for predicting hydrological changes in the 2050s. Results show that evapotranspiration will increase in most of the year. Runoff in summer to early autumn exhibits a decreasing trend, especially in spring season. From the viewpoint of fresh water resource availability, it is indicated that if water resources may not be sufficient in the future, water use efficiency will need to be improved. One possible solution is to store more water in the reservoir in previous summer.

P-2212b-14

Uncertainties in establishing hydrological impacts of climate change: what do we really know?

M. Tumbo (1)

(1) University of Dar es Salaam, Institute of Resource Assessment, Dar es Salaam, Tanzania, United Republic of

The success of climate impact assessment studies is partly dependent upon the uncertainties in the reliability of the future climate estimates derived from one or more GCMs or RCMs but also depend upon the ability of the hydrological model to represent the catchment responses to such changes. Thus, both hydrological and climate model uncertainties propagate through the entire assessment process and are not always easy to isolate. This study of the Great Ruaha River basin in Tanzania is based on the use of regional estimates of mean runoff, groundwater recharge and three flow points on flow duration curves (FDCs) to constrain ensemble outputs from the Pitman monthly model using Monte Carlo parameter sampling. The constraint bounds were quantified from gauged data available for 26 sub-basins together with assumptions about the spatial variations in hydrological response using limited physical sub-basin properties and climate data. The results are encouraging in that the simulated FDC ranges bracket the observed curves at two gauging stations downstream of many ungauged sub-basins that are important sites for water resources development decision making and climate data. The results show that evapotranspiration will increase in most of the year. Runoff in summer to early autumn exhibits a decreasing trend, especially in spring season. From the viewpoint of fresh water resource availability, it is indicated that if water resources may not be sufficient in the future, water use efficiency will need to be improved. One possible solution is to store more water in the reservoir in previous summer.

2213 - Ecological feedbacks to climate change

ORAL PRESENTATIONS

K-2213-01

How biodiversity mediates feedbacks from terrestrial ecosystems to climate change

S. Lavorel (1)

(1) CNRS, Laboratoire d’Ecologie Alpine, Grenoble, France

Climate change impacts ecosystems in multiple ways, in interaction with other global change drivers such as land use change, nitrogen deposition or biological invasions. These joint impacts may vary from radical shifts such as switches in vegetation types or loss of top predators to more subtle reorganisation of community composition and interactions across trophic levels. While their understanding has progressed tremendously over the past decades, many uncertainties still remain about their implications for earth system dynamics. This uncertainty is all the more critical as cascading impacts of biodiversity for the earth system have recently been recognised as one of the two highly integrated emergent system-level phenomena that are connected to all other planetary boundaries (Steffen et al. Science 2015).

Biodiversity affects ecosystem functioning and land surface properties through multiple mechanisms. These are often underpinned by so-called functional effects, which reflect the fact that the morphological, structural, biochemical or life history characteristics of organisms directly determine their effects on ecosystem properties, as well as their responses to global change drivers. In this presentation I will first review the diversity of functional mechanisms through which biodiversity affects ecosystem properties, and especially biogeochemical cycling. This review will emphasise the role of interactions among the functional characteristics of different groups of organisms that interact as part of ecological networks. Second I will summarise the available evidence across scales for such effects and highlight main uncertainties and gaps in terms of knowledge and data.

Lastly I will outline how some recent research terrestrial modelling efforts have started to incorporate functional diversity and its role in the response and effects of vegetation on biogeochemical cycling.

K-2213-02

Responses of marine ecosystems to climate change and ocean acidification

W. Cheung (1)

(1) University of British Columbia, Fisheries Centre, Vancouver, Canada

Changes in temperature, oxygen level, acidity and other ocean properties directly affect marine ecosystems through shifts in biogeography, phenology, productivity and trophic interactions. This paper synthesizes our latest understanding on the extent to which climate change and ocean acidification are affecting global marine ecosystems structure, functions and services and the resulting vulnerability. As shown by analyzing global marine biogeography records and fisheries data, ocean warming has already been altering marine species assemblages in the past four decades. Moreover, mapping of vulnerability of almost 1000 species marine fishes in the global ocean based on their exposure to climate stressors and biological sensitivity and adaptive capacity indicates that most of the studied marine fishes become highly vulnerable to climate change under high greenhouse gas emission scenarios. Such findings corroborate with results from simulation modelling of global shifts in distributions of marine fishes and invertebrates, highlighting the large climate risks of regional ecosystems, particularly in the tropics, in terms of decreases in biodiversity and key ecosystem services such as fisheries. Scope of adaptation to these changes may not be sufficient to substantially reduce these risks, particularly in sensitive ecosystems. This evidence emphasizes the urgent need to increase resilience of marine ecosystems to climate change, identify hotspots of vulnerable ocean regions to climate change, and highlights the need for ongoing interdisciplinary efforts between marine biologists, ecologists, economists, and politicians are needed to further reveal the multi-scales (spatial, temporal and
From cut twig to satellite – understanding the full response of phenology to climate change

A. Menzel (1)
(1) Technische Universität München, Ecology and Ecosystem Management, Freising, Germany

Phenology (the timing of seasonal natural events such as plant growth or animal migration) is now commonly used as indicator for evaluating responses of ecosystems to climate change. More than 500 papers are published annually that include "phenology" in their title and many of them are related to anthropogenic changes. Phenological changes have been reported across the globe, continents, ecosystems, habitats and taxa, predominantly as changes in flowering time (SDS) or as relationships to temperature and other drivers ("respones"); they have been summarized in various meta-analyses as well as in the IPCC WG II contributions to the AR4 and AR5. Although it has been well known during the 20th century that phenological events are triggered predominantly by climate, it was only in the late 1990s that phenology emerged as a key asset in identifying fingerprints of climate change, when significantly advancing spring events were identified on larger scales, proving the existence of thermal clines in Earth's microclimate in stands, provenances and origins, species, and responses has been related to geno-/phenotypes, as in the IPCC WG II contributions to the AR4 and AR5.

Since then, phenological research has made considerable advances but is now at a crossroads of understanding its full climate change response and associated variability. Especially, other drivers of phenology than forcing by spring temperature, such as chilling and photoperiod preventing too early spring development and thus damage by late spring frosts, precipitation, snow, nutrients, ambient CO2 concentration or management effects have contributed to understanding the full impact of climate-driven changes in natural systems, when significantly advancing spring events were identified on larger scales mirroring recent warming.

The timing of leaf development strongly regulates earth-atmosphere interactions and thus climate feedbacks, e.g. via biogeochemical cycles and impacts on the global energy balance, as well as biotic processes, such as pollination, agricultural and forestry production, and human health (via allergenic pollen). Thus, a full explanatory understanding of phenological drivers, accurate predictions and development of adaptation options are emerging topics which also need a full consideration of the observed variability in trends and responses. In data-intensive analyses of observations, the inherent variability may facilitate the correct identification of all drivers, whereas in novel experimental approaches, the observed variability may call for a higher number of species, treatments and replicates. Variability may yield to more plasticity and resilience to climate change and thus phenological responses will drive the fitness and adaptation capacities of species. In this review, I summarize the current knowledge and recent insights into observed changes in phenology from satellite data to micro-scale studies, and how the variability linked to species traits and regional climates and highlight the role of additional drivers other than spring climate recently derived from cut twigs. Only a full consideration of variation in these responses will allow a complete understanding of ecological, cultural and socioeconomic consequences of these phenological changes mirroring climate change, driving impacts in the biosphere and feedbacking to the climate system.
How soil microorganisms respond to and feedback climate change under non-extreme to extreme water fluctuations

JC. Lata (1); A. Kaisermann (2)
(1) IEEES Paris (Institute of Ecology and Environmental Sciences – Paris), Community Diversity & Ecosystem Functioning (DCFE), France, France; (2) The University of Manchester, Faculty of life sciences, Manchester, United Kingdom

The response of soil to water fluctuations is poorly understood which result in high uncertainties about the effects of climate change and the associated feedbacks. Through several French national and regional research programmes, treatments of drought–wetting (DW) intensities were simulated in microcosms and the dynamics of telluric microbial communities were followed to assess their stability in terms of diversity and function.

These studies highlighted a critical minimum moisture threshold below which microbial community stress was induced. Below this threshold, the wetting of dry soils induced (i) a large flux of CO2 called the ‘Birch effect’, which could be finely predicted from the intensity and duration of drought and wetting and (ii) erosion of bacterial diversity, leading to a structural instability in the following DW cycles. Despite an overall functional resilience, bacterial and fungal communities exhibited permanent modifications. Finally, the effects of DW events were also partially modulated by the soil physicochemical characteristics inherited from management practices.

Taken together, the integration of climate change drivers investigated in this work could improve the modeling of C fluxes in soils undergoing DW cycles that feedback both atmospheric and soil C compartments. It also raises the question of the existence of a tipping point in the decline of CO2 availability and the CO2 flush that occurs after rewetting. This is an alternative explanation for the increase in substrate availability and the CO2 flush that occurs after rewetting.

P-2213-03

Influence of climate changes on growth and initial development of tambaqui (Colossoma macropomum) larvae (Characiformes, Serrasalmidae)

MC. Portella (1); I. Guidini Lopes (1); TD.A. Silva (1); JT. Kojima (2); AL. Val (3)
(1) UNESP – Univ. Estadual Paulista, Centro de aquicultura da unesp, Jaboticabal, São Paulo, Brazil; (2) UNESP – Univ. Estadual Paulista, Faculdade de ciências agrárias, Jaboticabal, São Paulo, Brazil; (3) Instituto Nacional de Pesquisas da Amazônia, Manaus, Brazil

Introduction: The Amazon is the most diverse biome in the planet, hosting a number of plants, animals and microorganisms, being specially subjected to worldwide climate changes due to constant human activities affecting this biome. Amazonian species show important adaptation capacity, allowing them to explore challenging environments throughout the year. Larval development of fish is a very dynamic phase, marked by morpho-physiological changes during the organogenesis of the main systems. Therefore, initial phases are especially critical and the interactions with the environment define the adult individual. The aim of this study was to evaluate the effects of climate changes on the initial development of an important Amazonian fish species, the tambaqui – Colossoma macropomum.

Material and Methods: The predicted scenarios by the IPCC AR4 for climate change (Current CT, Mild B1, Moderate A1B and Drastic A2) were simulated in real time controlled microcosms – at the “Instituto Nacional de Pesquisas da Amazônia”, Manaus – AM, Brazil – based on the current climate conditions. Ten 9-L tanks, equipped with recirculation system, containing 300 newly hatched larvae each were positioned in each microcosm. Larvae were kept for 16 days and periodically collected to perform biometrics and yolk consumption analysis. Yolk consumption, notochord growth and standard length were analyzed by one-way ANOVA with Tukey post-hoc, and are presented as Means ± SE.

Results: Temperature, CO2 concentration, dissolved oxygen and water pH are shown in Table 1. Yolk consumption was not different among treatments throughout the five lecithotrophic days (mean areas on day 1 and day 5 of 0.7095 ± 0.007 mm² and 0.2583 ± 0.016 mm², respectively). Larvae submitted to the CT and A2 scenarios showed, by the end of the experiment, similar standard length (6.764 ± 0.170 mm and 6.877 ± 0.148 mm, respectively), but were significantly smaller (P < 0.05) than larvae in B1 and A1B (7.573 ± 0.141 and 7.804 ± 0.247 mm, respectively). During the first two days, high mortality was observed in all treatments (approximately 50%) due to an unknown cause, and by the end of the experiments, survival rates were calculated considering the initial density of the tanks. Survival rate in CT was 29.3 ± 0.4%, significantly higher (P < 0.05) than in A1B (26.3 ± 0.7%) and in A2 (24.7 ± 1.0%). In the B1 scenario, the survival rate was intermediary (27.5 ± 0.6%).

Discussion: The causes of high mortality in the first two days of the experiment could not be identified. However, the stress of the transportation of the yolk–sac larvae (about 200 km) and the water quality differences from the water of transportation and the water in the microcosms must be considered, despite the use of a rigorous protocol of acclimatization. When exposed to higher temperatures (A2), the larvae energy demand to supply the increased metabolism is also higher. Considering that yolk consumption did not differ among treatments, it is assumed that the efficiency of this initial source of energy in the yolk–sac larvae may have been compromised at higher temperatures, which could be related to smaller larvae and higher mortality. Treatments with intermediate temperatures (B1 and A1B, ranging from 29 to 30.5 °C) allowed better growth.

Conclusions: The predicted scenarios of future climate change by the IPCC for the end of the century, mainly the drastic ones, may affect the initial development of this Neotropical fish species, leading to high mortality rates.

Table 1. Mean values of temperature (temp, °C), CO2 concentration (ppm) in the air and water, pH and dissolved oxygen (DO, mg.L−1) in the tanks installed in each microcosm. Values are presented as Mean ± SE.

<table>
<thead>
<tr>
<th></th>
<th>Current</th>
<th>Blain</th>
<th>Moderate</th>
<th>Drastic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Room Temp</td>
<td>26.78 ± 2.08</td>
<td>28.72 ± 2.05</td>
<td>29.68 ± 2.01</td>
<td>31.70 ± 2.07</td>
</tr>
<tr>
<td>Water Temp</td>
<td>27.71 ± 1.19</td>
<td>29.23 ± 1.26</td>
<td>30.35 ± 1.07</td>
<td>32.05 ± 0.76</td>
</tr>
<tr>
<td>[CO2] Room</td>
<td>486.43 ± 32.69</td>
<td>690.00 ± 36.59</td>
<td>885.37 ± 28.42</td>
<td>1330.75 ± 30.49</td>
</tr>
<tr>
<td>[CO2] Water</td>
<td>5.26 ± 0.78</td>
<td>7.17 ± 1.35</td>
<td>11.16 ± 3.85</td>
<td>15.20 ± 2.84</td>
</tr>
<tr>
<td>Water pH</td>
<td>7.10 ± 0.22</td>
<td>7.03 ± 0.27</td>
<td>6.96 ± 0.22</td>
<td>6.80 ± 0.27</td>
</tr>
<tr>
<td>DO</td>
<td>7.02 ± 0.16</td>
<td>6.89 ± 0.26</td>
<td>6.99 ± 0.11</td>
<td>6.85 ± 0.16</td>
</tr>
</tbody>
</table>

P-2213-04

Effects of Climate Change on Bird Migration in Iran

S. Sadeghi Zadegan (1); M. Mahmoudi (2)
(1) Department of Environment, Natural Environment Deputy, Wildlife Bureau, Tehran, Islamic Republic of Iran; (2) Shahid Beheshti University, Tehran, Islamic Republic of Iran
Climate change can directly affect birds through changes in temperature and precipitation. Drainage of wetlands is from the direct effects of climate change, which can indirectly affect bird’s life. Around 70% of wetlands are seriously subject to dry or water loss. Even the rice fields, which defined as a wetland type, and very important for birds, are rapidly decreasing, converting to the other cultivations and uses. Birds in Iran are affected by climate change in various ways, such as distribution, abundance and migration. These statistics and observations suggest that the birds are selected more northern altitude for wintering. As well, they arriving to wintering grounds later and leaving the area a bit earlier. A huge breeding colony of Greater Flamingos are disappeared in Urumiyeh Lake due to serious drainage this international wetland. The Siberian crane is a critically endangered migratory wetland bird numbering 3,000 individuals worldwide, which breed in arctic Russia and Siberia, which recent climatic conditions in these areas have seen rivers dry up and lakeland lands to become more accessible to hunters. The western population of this species is dropped to only one single bird. Noting that climate change will put a lot of birds in danger of extinction. In the future, we will need to help birds to mitigate and adapt against changes. One way should be conserve local bird habitats, through the community based and grassroots programs and invested in on-the-ground projects involving Important Bird Areas.

2214 - Climate-ready adaptation for conservation and ecosystem services

**K-2214-01**

The response of species and ecosystems to large and rapid climate changes in the past: information for conservation policy in an uncertain future

IC. Prentice (1)
(1) Imperial College London, Department of Life Sciences, Ascot, United Kingdom

Contrary to the impression given by some recent, high-profile reports, climate changes of similar magnitude and rate to those projected for the 21st century have occurred repeatedly in the geologically recent past, during and at the terminations of glacial periods. The causes and geographic services, the future options for our future, we have quite different from those of contemporary climate change, which has two additional distinguishing properties: the fact that it is superimposed on a warm (interglacial) rather than cold (glacial) base state - and the fact that it could be the absence of mitigation - continue longer, and ultimately exceed the bounds of what the biota have experienced during several million years of Earth history.

Nonetheless, the palaeoecological record can provide uniquely valuable evidence on how the biotic response to a fast-changing environment. Examination of the last glacial termination from various perspectives offers surprising (and in many ways encouraging) findings. Known extinctions were few, except among large mammals. Among hundreds of tree species known to have existed worldwide at the last glacial maximum, only one became extinct. A variety of responses allowed the great majority of species to persist, either in place (through toleration or local habitat shifts), or by migration at remarkable velocities. These findings suggest a number of conservation policies that focus on the maintenance and spatial continuity of habitats. They also suggest that the species most vulnerable to climate change may also be those that suffer most from other, non-climatic pressures.

**K-2214-02**

Enabling transformative adaptation

M. Colloff (1); S. Lavorel (2); R. Wise (1); M. Dunlop (3); R. Gorddard (1)
(1) CSIRO, Land and water, Canberra, Australia; (2) CNRS, Laboratoire d’Ecologie Alpine, Grenoble, France; (3) CSIRO, Land & water, Canberra, Australia

The Transformed Adaptation Research Alliance (TARA) has developed an operational framework to study and support transformative adaptation, linking three novel concepts of ‘adaptation services’, the ‘values–rules–knowledge (vrk) perspective’ and ‘adaptation pathways’. Adaptation services describe future options provided to people by ecosystems, recognising changing societal perspectives on ecosystem management and use. The vrk perspective focuses on the societal system and how we can free up constraints on the decision context for implementation. The adaptation pathways concept provides the means for planning and sequencing the actions required for transformative adaptation. Uniting these concepts allows the exploration of interactions between changing biophysical systems and co-evolving societal systems in order to enable deliberation, choice and decision-making.

**K-2214-03**

Biodiversity conservation under climate change: do we need a new approach?

G. Mace (1); M. Dickinson (2)
(1) University College London, Genetics, Evolution and Environment, London, United Kingdom; (2) Imperial College London, Grantham institute – climate change and environment, London, United Kingdom

Climate change is predicted to have major implications for species and ecosystems, acting as a driver of biodiversity loss in its own right and amplifying the effects of existing threats. It differs from other pressures, such as land–use change or over-exploitation, in the global extent and pervasive nature of its potential impacts on biodiversity. The potential magnitude of climate change impacts calls for a policy response, but the type of response and the species or regions to be targeted remains unclear. Predictions for wide-scale extinction and disruption of communities and ecosystems has led some to question whether traditional conservation practices, such as protected areas, will continue to be effective. Others have called for radical and interventionist strategies, such as moving species from their current locations to regions predicted to be climatically suitable.

We will provide some recommendations for conservation management under climate change based on the emerging science of integrated vulnerability assessment. This uses multiple sources of information, a greater understanding of the mechanisms and drivers of vulnerability, and identifies proxies and predictors for sensitivity and adaptive capacity.

Effective conservation policy and practice will need to embrace some change rather than relying on methods. Distinctions between native and non-native species may become less relevant as species shift their geographic ranges. Global rather than regional or national targets or criteria for species or habitat protection or designation of protected areas may be more appropriate as species’ ranges and abundances change. A focus on ecosystem function and by resilience may be more appropriate than on maintaining species community composition. Traditional practices, such as protecting or restoring habitat within reserves, may support function and resilience by allowing existing systems to absorb the impacts of climate change. Improving permeability of the landscape or connectedness between reserves may be required to facilitate range shifts, either through spatial structuring of new reserves of by enhancement of natural linear features, such as rivers and hedgerows.

Uncertainty as to future climate may be, to some extent, irreducible and be incorporated into decision frameworks and interventions through adaptive management and scenario planning. Early applications of integrated vulnerability frameworks suggest that tropical regions may become centres of climate change vulnerability. Climate change, coupled with predicted increased in land-use...
change in these regions, suggests that tropical zones may be future centres of biodiversity loss. Stemming loss is likely to require a co-ordinated international response, with transfer of expertise and financial assistance from high-income developed temperate nations to assist low-income developing nations to implement new levels of human societal development in a sustainable manner.

K-2214-04

Powerful deliberate practices for enabling transformative adaptation

L. Fazey (1)
(1) University of Dundee, School of Environment, Dundee, United Kingdom

Anticipatory and transformative adaptation in the face of climate change, including for biodiversity conservation and maintenance of ecosystem services, is an intentional process. It requires the facilitation of the enabling conditions for significant and qualitative societal changes well beyond minor or incremental adjustments. Yet there is currently little understanding about how such deliberate significant changes come about, and at the rates necessary to reduce the threat of climate change. This presentation will therefore examine the nature and role of powerful deliberate practices (tools, activities, and processes) for helping to create the enabling conditions for transformative adaptation and conservation of biodiversity. The presentation will do four things. First, it will explain the concept of transformative adaptation and the challenges involved in facilitating enabling conditions. Second, it will explain the kinds of research that is that can simultaneously help understand transformation while also contributing to transformation in practice. This necessarily involves: (i) integrating existing theory, such as social practice theory and social technical transitions to overcome epistemological and ontological differences; and (ii) the bridging and integration of different kinds of knowledge, including academic (episteme) and that of practitioners (phronesis). Third, it presents a new concept called ‘powerful deliberate practices’ as a way to overcome some of the challenges of working on transformative change. This concept is important because its emphasis on: (i) ‘powerful’ highlights the need to understand which practices are most useful, for which circumstances, and why; and (ii) the bridging and integration of different kinds of knowledge and expertise highlights the need for approaches that can directly contribute to change in the present rather than, for example, looking to poorly suited past cases of change as analogues for the contemporary issues; and (iii) ‘practices’ highlights the need to understand the complexities and subtleties of interventions for conservation and adaptation as a collection of tools, activities and processes in a consistent and systematic way. Finally, an example of Three Horizons will be used of a potential powerful deliberate practice. Three Horizons is a process used to facilitate dialogue between individuals with different values and mindsets to map out processes of transition and transformation. The approach is able to both deal with situations of high uncertainty and has been found to create radical transformations in how participants relate to the future and view themselves as credible actors in shaping change, and is thus relevant to diverse circumstances, including transformative adaptation and the management of ecosystem governance and change. In conclusion, a research agenda is needed to develop, integrate and understand the role of a suite of powerful deliberate practices to accelerate learning about the enabling conditions for transformative change. This will necessary shape transformative modes of research that are significantly and qualitatively different from many of those already being applied.

O-2214-02

Global scenarios that achieve multiple sustainability targets: challenges for IPBES and IPCC

P. Leadley (1)
(1) Univ. Paris–Sud, Lab. Ecologie, Systématique et Evolution, Orsay, France

Several global sustainability goals for the 21st century have been agreed upon or are in the process of being agreed upon and set to be met by 2050. One of the key challenges facing the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) and the Intergovernmental Panel on Climate Change (IPCC) is assessing the feasibility of achieving these multiple targets simultaneously. This talk will review some of the key challenges facing the IPCC and IPBES (International Science–Policy Platform on Biodiversity and Ecosystem Services) in building a more comprehensive assessment of global scenarios of socio-economic development, including keeping global warming to 2°C or less for the 21st century (UNFCCC objective under discussion), halting the loss of biodiversity by 2050 (Convention on Biological Diversity) and attaining these while simultaneously meeting human development goals under the UN post–2015 global development goals currently under discussion. Scenarios of the global development suggest that achieving these multiple targets simultaneously will require substantial societal transformations. Many of these transformations have not been fully explored in global scenarios, and it appears that some of these transformations can play very large roles in achieving multiple sustainability targets. This talk will review some of the key challenges facing the IPCC and IPBES (International Science–Policy Platform on Biodiversity and Ecosystem Services) in developing the next generation of global scenarios of socio-economic development, using examples from the IPCC SSP scenarios, the Global Biodiversity Outlook 4, the UNEP Green Economy report and a wide range of published studies. This analysis suggests that certain transformations of food systems, in terms of marine fisheries, aquaculture, agriculture, food transformation and food consumption can make major contributions to achieving a wide range of sustainability targets.

2214–Poster Presentations

P-2214-01

Guiding Agricultural Expansion to Spare Tropical Forests

A. Bacchini (1) ; E. Dinerstein (2) ; M. Anderson (3) ; G. Fiske (4) ; E. Wikramanayake (2) ; D. McLaughlin (5) ; G. Powell (3) ; D. Olson (2) ; A. Joshi (6)

Expanding commodity crop production in the tropics presents the dual challenge of enhancing food production while preserving tropical moist forests (TMF) ecosystems and the carbon that they store. Over the years, biologists...
have prioritized biodiversity rich areas and made recommendations on conservation imperatives. Conversely, agricultural imperatives—and especially commodity crops—typically ignore biodiversity and carbon content values when converting new lands for expansion, even through the ecosystem services from the latter are vital to sustain the former. In this analysis we attempt to reconcile biodiversity, carbon storage, and agricultural imperatives by identifying low-carbon density land (LCDL) for large-scale agricultural expansion in the tropical realm. Thereby protecting important and representative biodiversity while minimize CO2 emissions. Our rationale is based on the fact that LCDL are essentially degraded TMF that have relatively low carbon cover and forest-dependent biodiversity. Because degraded TMF can take decades or even centuries to recover and mature, these lands are of limited conservation value relative to intact forest, especially with techniques such as tree density, basal area, diameter at breast height, height and age decreased with increasing elevation revealing dynamic nature of tree-lines though it presented some spatial heterogeneity. High regeneration of A. spectabilis compared to B. utilis indicated that the tree-lines in Nepal Himalaya are changing along with the species composition and dominance.

The upward shift of A. spectabilis was clearly observed, the shifting rate ranged from 1.1 m to 3.6 m per year. An invariant positive correlation among the site chronologies was also noted, indicating that there prevailed some common climatic factors limiting the growth and dynamics of the trees. Tree growth—climate and regeneration-climate relationship showed that warm winter and moist summer favoured the regeneration of A. spectabilis, while pre-monsoon (March-May) climate enhanced the radial growth. Growth of B. utilis in most of the sites was mainly limited by moisture stress during pre-monsoon months just before the main growth period. Population structure and climate growth and regeneration of A. spectabilis as compared to B. utilis was found to be different. High variability as well as warning line to the climatic impacts on high altitude biota and livelihood. Science based empirical information is necessary to expand the commodity and industrialized agricultural footprint with minimal loss of biodiversity and CO2 emissions.

Here, we propose a transparent approach for shifting agricultural expansion away from biodiversity and carbon rich TMF into degraded, low-carbon density lands, defined as lands holding less than 40 metric tons of Above Ground Carbon (AGC) and results showed that about 225 Million ha of low carbon density forests occur in the TMF tropical belt. After applying important safeguards, filtering for areas unsuitable for industrial agriculture, under formal protection, in indigenous reserves, or other biodiversity sensitive areas, about 125 Million ha are potentially available for tropical agricultural expansion for the next 25–50 years without further destruction of rainforests. About 65 Million ha of available LDDL estate is distributed in contiguous tracts larger than 5,000 ha and lies below 500 meters elevation, meeting the prerequisites for successful commercial-scale oil palm production. Nearly one third of all LCDL occur in Brazil; followed by India, Myanmar, Mozambique, Indonesia, Tanzania, and Democratic Republic of Congo, all holding more than 4 Million ha. The simplicity and transparency of this easily—monitored methodology could be useful to producers, investors, and consumers and enhance good governance in tropical regions.

P-2214-02

Tree-line Dynamics with Climate Change in Nepal Himalaya

D.R. Bhujut, (1); NP. Caire (2); P. Rana, (3); UK. Thapa, (4); SK. Shah, (5); M. Koirala, (1); M. Carrer, (6); S. Bhandari, (1); B. Sharma, (7); A. Shrestha, (8); R. Ghale, (9); YR. Dhakal, (10)

(1) Central Department of Environmental Science, Tribhuvan University, Kathmandu, Nepal; (2) Nepal Academy of Science and Technology Science, Tribhuvan University, Lalitpur, Nepal; (3) Nepal Academy of Science and Technology, Faculty of Science, Tribhuvan University, Kathmandu, Nepal; (4) Department of Geography, Environment and Society, University of Minnesota, Minneapolis, United States of America; (5) Birbal Sahni Institute of Paleobotany, Lucknow, India; (6) Department of Land and Agro—forest Environment, University of padova, Padova, Italy; (7) GoldenGate International College, Department of Environmental Science, Tribhuvan University, Nepal; (8) Sonepur Hydropower Company, Environment, Kathmandu, Nepal; (9) Karnali Integrated Rural Development and Research Center, Lalitpur, Nepal; (10) Tree Ring Society of Nepal, Kathmandu, Nepal.

The imprints of climate change impacts have evidently brought changes in the landscapes and climate. Available climatic data show a rapid increase in the average annual temperature in Nepal Himalaya compared to other regions. Nepal’s rich tree diversity emanating from varied climate within a narrow geography of extreme height. coupled with changes in river flow, these changes have led to significant alteration in tree species composition and distribution in both local and regional level. Recent observations have shown an increase in the spread of species that are dominant in drier ecosystems, as well as occurrence of tree species in areas previously occupied by grasslands, changing savanna grasslands to woodland. This dynamism is probably driven by the interacting effects of environmental variation, changing management regimes, human interactions, and climate. They probably experiences fluctuating species composition and wide variation in population dynamics of plant species, but none of this has been clearly documented.

P-2214-03

A Perspective on Conservation of Sub-Tropical Grassland in Eastern Himalaya

D. Das (1)

(1) ATREE, Bengaluru, India

The matrix of riverine grasslands and grassland—forest mosaics in the Ganges and Brahmaputra river valleys in the eastern Himalayas is inextricably linked to the tallest and most productive. These tall grassland forest mosaics are the last remaining examples of subtropical tall grasslands in the Indian subcontinent, and contain some of the highest densities of wildlife in Asia. These grasslands mosaic are maintained by a suite of disturbance processes including flooding, fire, and grazing. Manas National Park, a world heritage site and a tiger reserve with an area of 1,000 sq. km, situated in the north bank landscape of Assam. A socio-political change in the North bank landscape led to a disruption of management practices in the Park. These changes lasted over 15 years, and as a result, fire regimes and grazing practices changed. Wild populations of herbivores and carnivores suffered huge declines due to lack of protection. Coupled with changes in river flow, these changes have led to significant degradation of high altitude vegetation, biota and livelihood. Science based empirical studies on the impacts of climate change in high-altitude ecosystems are yet new approach in the Himalaya especially in Nepal.

We carried out a dendo-climatological study at the tree-line ecotones of seven high mountain protected areas of Nepal Himalaya from east to west, namely: Kanchenjunga, Sagarmatha (Everest), Langtang, Manaslu, Annapurna, Rara and Api-Nampa, with an aim to assess the impact of climate change in the tree—lines. Two to three sites were selected in each protected area. Vertical transect plots of 10–20 m x 10–25 m were laid down in each tree-line site covering different aspects of mountain slopes. In addition to ecological details, more than 1200 tree core samples from major tree-line species, viz. Abies spectabilis D. Don, Betula utilis D. Don and Rhododendron campanulatum D. Don were collected. Using the ecological and dendrochronological tools, climatic response on radial growth and regeneration, recruitment and dynamics of these species were analyzed.

The position of tree—line in the east (Lat. 27.7155 N) was higher (Alt. 4150 m asl) in the west (Lat. 3800 m asl; Lat. 29.5730 N). Thus the imprints of climate change impacts have evidently brought changes in the landscapes and climate. Currently, the high altitude biota and livelihood. Science based empirical information is necessary to expand the commodity and industrialized agricultural footprint with minimal loss of biodiversity and CO2 emissions.
Commodifying Nature, Where we were mistaken with Ecosystem Service Classification

A. Dhungana (1)
(1) Center for Climate and Environment Research, Policy and Economics Research Unit, Lalitpur, Nepal

Economic theory driven ecosystem valuation has been the fundamental areas for the Ecosystem Service (ES) and Payment for Ecosystem Services research in the last decade. The Classification of ES by MEA 2005, has diversified the whole research community to think Nature as a Commodity and the research community for this whole decade spend their huge effort in the monetary valuation of Nature, but still we are far away from the solution within nature–human–development nexus. The major problem in this classification was with the cultural service, weighted in similar fashion with other three provisioning, supporting and regulating service. Our empirical Study has shown that, with all three services, cultural service was interconnected and no way can be treated as a separate class. Besides, the complexity of natural process like hydrological cycle, nutrient cycle and climate change was categorized in regulating and supporting services needed research on the long term nature, and it can no way be monetised like other economic goods, and hence results fell in the failure to measure and manage it for the transformative solutions in our societies. The economic theory like utility and welfare theories in no way could justify the interlinkage of nature and economy.

Impacts of Biodiversity Loss in the Carbon Stock and Evapotranspiration Fluxes Regulation in Brazilian Amazon

R. Ferraz (1); M. Simões (2); M. Equihual (3); O. Maqueo (3); N. Alainz (4); P. Verveijs (5); A. Alvez (6)
(1) Embrapa, Embrapa Solos, Rio de Janeiro, RJ; Brazil; (2) Embrapa, Embrapa sofos, Rio de Janeiro, Brazil; (3) INEOL, Instituto de ecologia oriental, Brasil; (4) CONABIO, Comision nacional para el conocimiento y uso de la biodiversidad, Mexico DF, Mexico; (5) Wageningen–UR, Alterra, Wageningen, Netherlands; (6) Universidade do Estado do Rio de Janeiro, Programa de pos–graduação meio ambiente (ppgma), Rio de Janeiro, Brazil

Biodiversity supports many ecosystem services that are very important for climate change mitigation and adaptation, according to the Convention on Biological Diversity (CBD) there are clear interlinkages between biodiversity and climate changes. There is a functional link between the tropical forest ecosystem biodiversity and their capacity for carbon uptake and storage as well as regulation of evapotranspiration flux. Nevertheless, land use changes and agriculture expansion reduce the ecosystems integrity modifying the functions related directly to the ecosystem services. The relationship between biodiversity and ecosystem services in tropical forests, in front of the ongoing global climate change, has been quite accepted by the scientific community, but needs to be better quantified and understood. The objective of this paper is to present the methodology approach and preliminary results on the impact estimation of land use changes and ecosystem biodiversity loss in carbon stock and evapotranspiration fluxes regulation ecosystem services. In order to fulfill that goal, the carbon stock and evapotranspiration spatial model was set up instead of an ecosystem service model used as an indicator of biodiversity loss for the Brazilian Amazon. The methodological approach of this work consists in the generation of an ‘ecosystem biodiversity loss’ spatial model based on probability distribution of evidence parameters (Bayesian theory – Lindley 1972). The modeling was based on learning process (data–driven model) using the Expectation Maximization algorithm (Bacqasse 1994). Bayesian network has been established from an expert conceptual model that related different spatial data (Thematic maps and Remote Sensing data): (i) Biomass (MODIS/ USGS – NASA); (ii) EVI; (iii) LAI- Leaf Area Index (MODIS/ USGS – NASA); (iv) GPP- Gross Primary Productivity (MODIS/ USGS – NASA). The carbon stock ecosystem service was estimated from aboveground carbon stocks spatial model developed by Baccini et. al. (2004) within the Panter model used as an indicator of biodiversity loss for the Ethiopian Amazon. The methodological approach of this work consists in the generation of an ‘ecosystem biodiversity loss’ spatial model based on probability distribution of evidence parameters (Bayesian theory – Lindley 1972). The modeling was based on learning process (dada–driven model) using the Expectation Maximization algorithm (Bacqasse 1994). Bayesian network has been established from an expert conceptual model that related different spatial data (Thematic maps and Remote Sensing data): (i) Biomass (MODIS/ USGS – NASA); (ii) EVI; (iii) LAI- Leaf Area Index (MODIS/ USGS – NASA); (iv) GPP- Gross Primary Productivity (MODIS/ USGS – NASA). The carbon stock ecosystem service was estimated from aboveground carbon stocks spatial model developed by Baccini et. al. (2004) within the Panter model used as an indicator of biodiversity loss for the Brazilian Amazon. The methodological approach of this work consists in the generation of an ‘ecosystem biodiversity loss’ spatial model based on probability distribution of evidence parameters (Bayesian theory – Lindley 1972). The modeling was based on learning process (dada–driven model) using the Expectation Maximization algorithm (Bacqasse 1994). Bayesian network has been established from an expert conceptual model that related different spatial data (Thematic maps and Remote Sensing data): (i) Biomass (MODIS/ USGS – NASA); (ii) EVI; (iii) LAI- Leaf Area Index (MODIS/ USGS – NASA); (iv) GPP- Gross Primary Productivity (MODIS/ USGS – NASA). The carbon stock ecosystem service was estimated from aboveground carbon stocks spatial model developed by Baccini et. al. (2004) within the Panter model used as an indicator of biodiversity loss for the Brazilian Amazon.
A theoretical analysis of a hypothetical auction program to pay for biodiversity in Peruvian Amazon nuts (Bertholletia excelsa) ecosystems

P. Flores Tenorio (1)
(1) La Trobe University, Department of Economics, Melbourne, Victoria, Australia

Peru is a megadiverse country with the second extension of forests in the Amazon basin. The design of efficient public policies for these territories is challenging due to the fragility of public institutions and lack of economic valuation of important ecosystem services provided from old-growth forests.

This paper develops a preliminary dynamic system model and a theoretical analysis from the ecological economics perspective for a key non-timber forest product of the Peruvian Amazon basin: the Amazonian açaí berry (Bertholletia excelsa). Specially, we analyse the bioeconomic dimensions of two ecosystem services: pollination and the forest cover to provide habitat for flora and fauna.

The contribution of this paper is to present evidence that support the argument that decision makers from development countries have an excellent investment opportunity for conservation of biodiversity in indigenous lands with Amazon nuts.

P.2214-08

West Africa's most climate change vulnerable species: which, where and why?

W. Foden (1) ; J. Carr, (2) ; E. Belle, (3) ; N. Burgess, (4)
(1) Global Change and Sustainability Research Institute, University of the Witwatersrand, Gauteng, South Africa; (2) IUCN Global Species Programme, Cambridge, United Kingdom; (3) UNEP-World Conservation Monitoring Programme, Brussels, Belgium; (4) UNEP-World Conservation Monitoring Programme, Cambridge, United Kingdom

West Africa supports globally high levels of species richness and endemism but this exceptional biodiversity is subject to serious ongoing anthropogenic threats, particularly from land transformation and over-exploitation. Climate change is now recognised as a serious emerging threat to biodiversity, due both to its direct impacts on species’ health and habitats, and because some human responses are likely to exacerbate historical threats. In order to prepare sound climate change adaptation strategies for West Africa, it is necessary to understand how biological systems will be impacted. To address this need, we carried out climate change vulnerability assessments for almost all of the region’s terrestrial and freshwater vertebrates, including birds, mammals, amphibians and fishes (2,854 species). Using a trait-based approach, we worked with species experts to identify traits conferring high climate change sensitivity and low adaptive capacity for each taxonomic group, and then scored each species’ degree of possession of these. Species’ exposure to climate change was estimated using regional projections of future climate across their individual distribution ranges. Combining the resulting sensitivity, exposure and adaptive capacity scores, we categorised each species’ overall climate change vulnerability. This allowed us to identify those facing highest risk from climate change, as well as the areas where such species are concentrated. By comparing the patterns of high climate change vulnerability with those of high threat from non-climate related factors allowed us to identify areas of greatest concern for West Africa’s most vulnerable species. By comparing these priorities with current protected area coverage, we highlight areas that are currently unprotected but in great need of protection, as well as the existing protected areas in which adaptation efforts should be prioritised.
ABSTRACT BOOK

Community Forest of Nepal: How it maintains ecosystem services and maintain sustainability?

B. Khadka (1)
(1) Yokohama National University, Yokohama, Kanagawa, Japan

Community forestry is a participatory forest management system in Nepal. Till date, 17,000 community forest (around 1.2 million ha) forest is managing directly from the 1.5 million people.

Research shows that the environmental services provided by the Community forest such as provisioning services, regulatory services, cultural services, supporting services, biodiversity conservation, water purification and regulation, soil erosion protection, forest recreation and carbon storage are gaining some attention and need to protect the future of the forests linking commercial market and climate change adaptation and mitigation issues activity to conservation objectives from past 30 years. Moreover, selling forest environmental services for the coping with climate change should ensure through the effective payment system in securing forest environmental benefits and their role in effort to eliminate rural poverty and also helps further for climate change mitigation and adaptation. The government of Nepal is developing different policy and management plan how can get more benefit from the community forest such as Payment for ecosystem services, Carbon market, Reducing Emissions from Deforestation and degradation plus, ecotourism, green jobs from the forest etc which can make direct benefit to the community people and helps to cope with climate change.

This research explore how community forest maintains ecosystem services and maintain sustainability, resilience development for community?

Sectoral contributions to the conservation of biodiversity

M. Kok (1)
(1) PBL Netherlands Environmental Assessment Agency, Bilthoven, Netherlands

In 2014, governments within the Convention on Biological Diversity (CBD) reviewed progress in the achievement of the goals and targets set in the Strategic Plan on Biodiversity 2010–2020, as a step towards halting the loss of biodiversity in the 2050 Biodiversity Vision. Although there has been an increase in responses to stop the further loss of biodiversity, this progress is insufficient to attain most of the Aichi Targets by 2020, nor can under current trends a stabilization of biodiversity loss towards 2050 be expected. This is for a large part due to persistent increases in pressures. To be able to address these, biodiversity policies need to address primary production sectors. Developments in sectors such as food production and agriculture, wood production and forestry, energy production, water management and fisheries largely shape the world’s current and future biodiversity, as they exert direct pressures on biodiversity.

Related to the Aichi targets on sustainable use we identify different pathways that could contribute to achieving the 2050 Biodiversity Vision. Pathways are combinations of technological measures and behavioural changes, for food production and wood production and consumption. Biodiversity goals in these pathways are realized as part of a broader set of sustainability objectives, including eradicating hunger, feeding an increased and more wealthy world population, providing universal access to clean drinking water and sanitation, reducing greenhouse gas emissions and improve the well-being of all people simultaneously, but that this requires substantial transformations in the sectors we researched.

Biodiversity implications of REDD+ policies: assessments in Brazil and in the Congo Basin

R. Mant (1) ; B. Bodin, (1) ; A. Mosnier, (2) ; A. Sotterrini (3) ; FM. Ramos (3) ; AXY. Carvalho (4) ; G. Câmara, (5) ; J. Pirker (5) ; R. Odermatt (2) ; E. Leyequien (1) ; J. Verboom (2) ; JA. Harvey (3) ; T. Essens (3) ; C. Vos (2) ; WF. De Boer (4)
(1) CENTRO DE INVESTIGACIÓN CIENTÍFICA DE YUCATAN, Unidad de recursos naturales, Mérida, Yucatan, Mexico; (2) WAGENINGEN UNIVERSITY AND RESEARCH CENTRE, Alterra, Wageningen, Netherlands; (3) Netherlands Institute of Ecology NIOO–KNAP, Department of terrestrial ecology, Wageningen, Netherlands; (4) WAGENINGEN UNIVERSITY AND RESEARCH CENTRE, Resource ecology group, Wageningen, Netherlands; (5) WAGENINGEN UNIVERSITY AND RESEARCH CENTRE, Resource ecology group, Wageningen, Netherlands

Anthropogenic climate change has affected Earth’s biota on all continental and ocean territories. Global and regional climatic changes affect the world’s faunas, causing among others shifts in their geographic ranges, changes in their seasonal activities, species turnover, increasing the risk of extinction, of spread of diseases and of invasive species. Species’ range shifts have been the focus of attention of climate change studies, and vast amounts of correlational evidence show that the geographic range of species around the world is shifting either in latitude or elevation in response to climate change. There is no doubt of the importance of correlational studies describing the connection between the range shifts in species and climate change, however a great challenge in ecology is to commute from a simple correlational claim to the understanding of the underlying causal mechanisms.

Understanding species’ range shifts entails knowledge of the underlying causal mechanisms of the observed phenomena, to ultimately understand the future directions of global faunas under climate changes. Mechanistic explanations of animal range shifts – or their absence – should account for ecological traits that strongly influence species’ responses to climate change. For example physiological thresholds that determine climatic limits to species distributions, or other example is species’ dispersal limitations that may compromise the capability to disperse at rate that is sufficient to track the changes in suitable bioclimatic space, causing time lags and thereby leading to novel community structures and novel interactions. We propose a comprehensive framework linking mechanistic explanations to causal claims in explaining range shifts, present and future, under changing climate zones. First, we illustrate the mechanistic explanations underlying animal range shifts driven by climate changes using a series of case studies contrasting the northern and southern hemispheres. We discuss as well the resulting effects exerted by range shifts at different ecological levels, from micro–evolutionary processes through selection of phenotypes, to ecological communities and ecosystems; and identify consequential feedback loops. Our theoretical framework provides a synthetic robust broader approach that links hypotheses and underlying mechanisms to advance our understanding of climate change impacts on global faunas, and provides grounds for generalisations that can direct future research and lead to evidence-based solutions to climate change challenges.

Community Forest of Nepal: How it maintains ecosystem services and maintain sustainability?

Climate change impacts on global faunas: the causes and consequences of range shifts

E. Leyequien (1) ; J. Verboom (2) ; JA. Harvey (3) ; T. Essens (3) ; C. Vos (2) ; WF. De Boer (4)
(1) CENTRO DE INVESTIGACIÓN CIENTÍFICA DE YUCATAN, Unidad de recursos naturales, Mérida, Yucatan, Mexico; (2) WAGENINGEN UNIVERSITY AND RESEARCH CENTRE, Alterra, Wageningen, Netherlands; (3) Netherlands Institute of Ecology NIOO–KNAP, Department of terrestrial ecology, Wageningen, Netherlands; (4) WAGENINGEN UNIVERSITY AND RESEARCH CENTRE, Resource ecology group, Wageningen, Netherlands

Climate change through the reduction of emissions and also helps further for climate change mitigation and adaptation. The government of Nepal is developing different policy and management plan how can get more benefit from the community forest such as Payment for ecosystem services, Carbon market, Reducing Emissions from Deforestation and degradation plus, ecotourism, green jobs from the forest etc which can make direct benefit to the community people and helps to cope with climate change.

This research explore how community forest maintains ecosystem services and maintain sustainability, resilience development for community?
from Deforestation and forest Degradation plus the conservation of carbon stocks (REDD+) in order to mitigate climate change. Policies aimed at achieving REDD+ objectives will have major impacts on future land use and land cover, both within and outside protected areas, which in turn affect biodiversity. Countries in both regions have committed both to supporting the achievement of the goals of the Convention on Biological Diversity (CBD) including the Aichi Biodiversity Targets (CBD) in its Strategic Plan, and to addressing and respecting the safeguards developed by the UNCCD to minimise social and environmental risks and enhance the benefits of REDD+. Therefore, understanding how different policies may influence land use and biodiversity is essential to informed decision-making and identifying REDD+ policies that can help safeguard biodiversity. We are assessing the potential impacts of REDD+ policies on biodiversity in Brazil and the Congo Basin by using an economic land use model (GLOBIOM), to project future land use and land cover under several different scenarios. The biodiversity impact of the different scenarios is then explored by assessing the locations of projected land use change in relation to ecological regions, nationally and regionally identified priority areas for biodiversity conservation and species ranges. The effect of potential differences between ecoregions in land use policies and their application are explored. The impacts on species distributions relative to different types of land use change. The different assessments of impacts on biodiversity can in combination inform both REDD+ and biodiversity policies. In Brazil, both the implementation, and the impacts, of the Forest Code differ between Amazonia and other biomes. Therefore, understanding how different policies may influence land use and biodiversity is essential to informed decision-making and identifying REDD+ policies that can help safeguard biodiversity.

**P-2214-15**

Multi-Temporal cover patterns using Landsat TM in the Tapajós National Forest and its surroundings: a case study

L. Martorano (1); L. Lisboa, (2); C. Vettorazzi, (2); R. Muniz, (2); NES. Beltrão (3)

Brazil’s Tapajós National Forest (Flona Tapajós) – a conservation unit, under the National Forest Use Group created by Decrease No. 75,684 (February 1974) – measures approximately 527,000 hectares (ICMBio, 2012). This CU has undergone constant changes in usage patterns, both natural and induced, especially due to activities related to agriculture, livestock and timber harvesting. In June 2012 Federal Law No. 12,678 reduced the area of Tapajós Flora by approximately 4% of its former size, leaving 17% of the area to be used as a protected area. According to Batista et al. (2013), this reduction may lead to possible threats in the maintenance of goods and services that Flona offers, provoking with the class R2 the expansion of areas classified R2 in its surroundings, thus increasing pressure on the protected area. Therefore, the aim of this work was to identify and map spatial distribution patterns of use and land cover after the alteration of the landscape using data from spatio-temporal remote sensing sources. Satellite images from the TM sensor and the Landsat-5, from July and August of 1989, 2005 and 2009 were used. Digital processing was performed: atmospheric correction; geometric correction; mosaic; classification; post-classification and definition of use classes and land cover. We used the Geographic Information System (GIS) ArcGIS v.9.3 to construct thematic maps of the study area, along with the following procedures: conversion of classified images to vector format for calculating the areas of thematic classes adopted this work; assembly and mapping calculation of the area and overlapping the results to detect changes between the years studied.In Flona Tapajós and its surroundings, between 1989 and 2005, the areas with Native Forest (NF), Regeneration (R), Recent Degradation (RD) and Eutrophicated (ES) remained unchanged or increased respectively 62, 3 and 2%. The altered areas (17%) underwent their most drastic changes in areas with NF (9%) and in 2005 were identified as R (2%) and RD (3%). While ES and NF class R2 had not been removed, reaching stage R2 2005. The remaining 6% suffered conversion between ES and RD (Table 1). In the period 2005–2009, the areas with NF, R, RD and ES that remained unchanged were 66%, 8%, and 6% respectively (Table 2). It is noteworthy that 11% belonged to Water bodies in both periods. In the period 1989–2009 there was a 11% reduction in NF areas. In the second period, its reduction was approximately 1%. On the other hand, the area (R) made up only 4.5% in 1989 and grew to 7.6% in 2005, reaching about 11% of the area in 2009.Areas with RD represented 5% in 1989 and 7% in 2005 and 2009, indicating that the «Government Programme Zero Deforestation in the Amazon» shows evidence of consolidation in Flona Tapajós and its surroundings. This fits with the trend in ES, which went from 14% in 1989 to 21% in 2005, causing that, despite the reduced fragments located within Flona Tapajós, its environment, in particular its buffer zone, underwent a robust process of human disturbance. From the results, we conclude: Between 1989 and 2005 there was a higher percentage of loss patterns in the Native Forest than occurred from 2005 to 2009 and the patterns remained stable in 2009. In the Tapajós National Forest and its surroundings indicates the importance of legally protected areas for the conservation of goods and services offered by the people as a result of the preservation of natural and non-natural landscapes can support the understanding of the observed dynamics of use and coverage. In addition, the assessment provides support for analysis of the effects of fragmentation in the region. The non-linear and non-linear dynamics in Flona Tapajós and its surroundings indicates the importance of legally protected areas for the conservation of goods and services offered by the people as a result of the preservation of natural and non-natural landscapes. In addition, with other information and analysis, these dynamics may uncover possible threats to the maintenance of goods and services that sustain the biodiversity of the region.

**P-2214-16**

Scenario analysis of the main drivers forces threatening the conservation of the Tapajós National Forest, Brazilian Amazon

N. Nascimento (1); L. Martorano, (2); NES. Beltrão (3)

(1) National Institute of Spatial Research, Terrestrial system sciences department, São José dos Campos, SP, Brazil, (2) Embrapa, Agrometeorologia, Belém, Brazil, (3) State University of Pará, Applied Social Sciences, Belém, PA, Brazil

Several public policies were released in an attempt to integrate the Amazon to the other regions of Brazil in the 1960s. Amongst the main engagements on infrastructure, the government built ports, hydroelectric facilities, and opened highways such as the Transamazônica (BR-230), Cuiabá–Santarém (BR 163) and Belem–Brasilia (BR-16), triggering an aggressive process of landscape transformation and development in the region. However, the government instituted legally protected areas in the region, such as the Tapajós National Forest (FLONA), in 1974. The road was extended in 2012 and is now part of the national complex, between two major highways in the region. The Tapajós National Forest suffers influence of the Transamazônica highway (BR-230) in the South, and the Cuiabá–Santarém highway (BR-163) located in its Easten side, which leads to Santarém, São Luís and São Gonçalo. Hydroelectric pressures generated by its surroundings, the protected area has presented suitable conservation indicators. However, it is noteworthy that the west side of Pará concentrates the greatest number of power plants, the Cargo Transhipment Stations (ETC), and also the paving of highways BR-163 and BR-230. Thus, the objective of this analysis is to provide a description of changes over time, but also to point out future trends and identify higher-pressure areas. This study addresses efforts to investigate landscape changes in the Tapajós National Forest and its surroundings, which covers a total area of 19,627 km², including the municipalities of Belterra, Santarém, Aveiro, Rurópolis, and Placas. The
Considering the infrastructure, we selected roads, municipal offices, land tenure (settlements, Conservation Units and Indigenous Lands) and localities. Biophysical elements included slope, aspect, temperature, rainfall, altitude and slope. All variables were crossed with land use data made available by the project TerraClass (INPE) for 2008 and 2010. For each municipality, we sought information on the implemented land extraction through production to subsidize economic data provided by the results of spatial analysis process. Data were spatialized by using the geostatistics analysis, modeling and scenario generation in the LFE Institute system in 2012 that provided a detailed analysis for each vector element of change in the landscape, in addition to its role in the spatial dynamics of the study area.

The results showed that amongst the variables used as landscape transformation vectors, the roads appear to be the main drivers of change in every scenario, which means a change in the use and configuration of production systems. Taking into account the total area analysed, sites from Rural Settlement present more probability for transitions. The remaining areas with most probability for transitions are those with the lowest declivity values, who use agricultural machinery on the yearly cultivation of soy and corn. The remaining transitions follow the deforestation pattern, as the Tapajós, along the Transamazônica highway. Inside the National Forest, the road that connects the São Jorge Community to the Tapajós across the Forest, at the Km 67 on Highway 163, is a major anthropic pressure. The hypothesis is that in 2012 this community was no longer under the control of ICMBio. In the map, the yellow and red dots indicate the places with higher chance of changing in the year 2030. According to the map, there are two areas of concern: the South side of FLONA, for the settlements controlled by INCRA (National Institute of Colonization and Agrarian Reform); the West side, where the Santarem–Cuíabá road is being renewed. The South side contour point for biological conservation gives an intense use of the soil by farmers from the Settlements. The altitude, intense rainfall rates, the areas for settlements, and the predicted scenario for the year 2030 are elements that strengthen the need for integrated Crop–Livestock–Forest systems to relieve the pressure on the south side of the Tapajós National Forest. Based on the results, we conclude that the emancipation of the São Jorge Community entails a threat for this Conservation Unit. in addition, it is recommended that the ICMBio should have a more strict access control to the Tapajós River.

P.2214-17
On the need to integrate microclimates and thermal limits when forecasting warming tolerance of organisms

S. Pincebourde (1); J. Casas, (2)
(1) CNRS, Institut de Recherche sur la Biologie de l’Insecte (IRBI), Tours, France; (2) Université François Rabelais, Institut de recherche sur la biologie de l’insecte (IRBI), Tours, France

The impact of warming on the persistence and distribution of ectotherms is often forecasted from their warming tolerance—inferring the difference between their upper thermal limit and habitat temperature, which is usually taken as the macroclimate temperature. Ectotherms, however, are thermallyadapted to their microclimates, which can deviate substantially from macroscale conditions. Ignoring microclimate deviations therefore inflates estimates of warming tolerance. We compared warming tolerance of a leaf miner insect across its ontogeny when calculated from macro- and microclimate temperatures. We used a heat balance model to predict experienced microclimate temperatures from macroclimate, and we measured thermal limits for several life stages (egg, larval stages 4 and 5, and pupae). The model shows a 4°C increase in microclimate temperature and 7°C thermal limits across insect ontogeny despite they all experience the same macroclimate. Consequently, warming tolerance, as estimated from microclimate temperature, is higher in microclimate than macroclimate across ontogeny. When calculated from macroclimate temperature, however, warming tolerance was wrong by over 7–10°C depending on the life stage. Therefore, large errors are expected when projecting persistence and the distribution of ectotherms in changing climates using macroclimate rather than microclimate.

P.2214-18
Inferring the effect of climate change on dispersal-limited species in the Brazilian Atlantic rainforest with collection data and targeted field sampling

V. Tarli (1); P. Grandcolas (2); R. Pellens (2)
(1) Muséum National d’Histoire Naturelle, CNRS UPMC EPHE, Institut de systématique, évolution, biodiversité, umr 7205 isyeb, Paris, France; (2) Museum National d’Histoire Naturelle, CNRS UPMC EPHE, Institut de systématique, évolution, biodiversité, umr 7205 isyeb, Paris, France

Inferring the effect of global change is especially difficult in tropical biodiversity hotspots. These places shelter a large and poorly known part of the world’s biodiversity, with many species that cannot track environmental changes due to their limited dispersal ability. Tropical hotspots are also submitted to the fastest man-induced environmental changes. Therefore, even strongly targeted field samplings cannot be fast and comprehensive enough to provide knowledge for taking management and conservation decisions. Sampling needs to be completed by data already obtained and accumulated for decades in Museum collections. Better than being simply supplementary, these data are often critically complementary, since they represent the only available information for future natural ecosystems that are already largely destroyed, allowing for composing more real models of species requirements and distributions. We carried out a study to understand the effect of climate change on one of the most remarkable hotspots of biodiversity, the Brazilian Atlantic rainforest, fragmented in thousands of remnants, and extending on more than 3 000 km from Nordeste to Uruguay. Our goal was to evaluate the ability of dispersallimited and poorlyknown species to survive climate change and also to assess how much collection data from Natural History Museums complement a targeted field sampling. We focused on one model organism, the saprophagous insect genus Monastria Saussure, 1864 (Dicyoptera, Blaberidae) endemic of the whole rainforest hotspot, abundant but till poorly known, dispersallimited and unable to track climate change.

We conducted a targeted field sampling by visiting 67 locations distributed all over the Atlantic rainforest in geographical and altitudinal extremes and including all forest physiognomies, and by also sampling secondary forests and areas with other land uses. This was complemented with specimens from collections from 13 Natural History Museums. We used the Species Distribution Model (SDM) MaxEnt to model present and future potential habitats based on sets of 19 Bioclim climatic variables. For current climate, we used the data from 19502000 provided by Worldclim. The habitat modelled with collection data nicely overlaps in 89% that obtained with targeted field sampling. It covered almost the entire range of the 19 climatic variables assessed with targeted samples, which shows how useful it can be to consider it.

In order to assess the amount of habitat available for Monastria in future climate we used two climatic models for 2050 and 2070, derived from climate surfaces IPCC HadGEM2ES and MIROC5 (http://www.worldclim.org, IPCC 2007). For each model we applied to pooled data sets, we used two outputs (RCP 4.5 and 8.5), representing roughly a pessimistic and optimistic greenhouse scenario according to CO2 emissions. We already know from previous studies that the Monastria with apterous females is unable to move between remnants of primary forest by using inhospitable matrix (grasslands, diverse plantations) or secondary forests where it is not found. We searched the extent of forest remnants that are capable to host Monastria now and in the projected future climates. Our results point for a critical situation in which a maximum of 4% of the present distribution area will fit Monastria’s habitat requirements in 2050 and 2070. This calls attention to the need for considering the most frequent case of dispersallimited species in relation to habitat connectivity when evaluating the potential effect of climate change.
Agent-Based Modeling of Reasonable Consumption for Grassland Ecosystem Supply Service in Inner Mongolia, China

H. Yan (1); P. L. (2); L. Zhen, (3)
(1) IGSNRR, CAS, Beijing, China; (2) IGSNRR, Beijing, China; (3) IGSNRR, CAS, Beijing, China

Sustainable ecosystem service is of vital importance to the survival and development of human society. How to balance the conflicts between the ecosystem protection and the ecological consumption of local residents has been a serious challenge today especially in ecologically vulnerable area. In order to find out reasonable consumption approaches of the grassland ecosystem supply service and explore the sustainable land management strategies for the local social–ecosystem, taking Hulun Buir Inner Mongolia Autonomous Region as the case study region, based on the agents’ behaviors rules derived from households survey, an Agent-Based Model (ABM) has been developed in this study for simulating the ecosystem consumption pressure under different grassland management scenarios. This model links the supply and consumption of grassland ecosystem service by calculating ecosystem NPP supply and households NPP consumption. The model includes three sub-models: Individual growth status sub-model, Households’ land-use sub-model, and Ecosystem service consumption pressure sub-model. In accordance with the multi-objective land management practices in case study area, four land management scenarios were modeling in this study, (1) business as usual, (2) aiming at increasing household’s living level, (3) aiming at ecosystem protection and (4) aiming at balancing the ecosystem protection and living level improvement. The result indicates that the reasonable consumption mode is possible in the research region, under which the indicators including ecosystem pressure, NPP supply, forage consumption of livestock, households incomes and herders’ living level could reach a reasonable and sustainable level. This reasonable consumption mode is an improvement of traditional grazing mode, which could stimulate herders to control the livestock marketing rate by rational ecological compensation measurements, so as to ensures the NPP consumption is close to but never beyond the threshold.

Tropical Forest Degradation in the context of climate change: increasing role and research challenges

P. Sist (1); J. Chave (2); E. Rutishauser (3)
(1) Cirad, Montpellier, France; (2) CNRS, Laboratoire evolution et diversité biologique (edb), umr S174, Toulouse, France; (3) CarboFor-Expert, Genève, Switzerland

While developed countries in temperate regions faced their forest transition about 100 years ago or more, “tropical forest rich” nations still largely depend on forest resources or land clearing for their development. Hence, tropical forests are more at risk than temperate ones to activities like advancing cash crops, such as oil palm, soybean, or cattle ranching. Beside tropical deforestation, tropical forest degradation refers to forest degradation from activities other than deforestation such as: human induced predator or illegal logging, non-timber forest product extraction, fuel wood extraction) significantly contributes to greenhouse gas emissions and loss of biodiversity. If deforestation is an obvious ecosystem change, forest degradation is more difficult to discern and quantify. Degraded forests have become a major component of today’s tropical landscapes, representing up to 50% of all tropical forests. For example, almost half of standing primary tropical forests, up to 400 million ha, are designated by national forest services for timber production. The portion of tropical forests managed for timber extraction, hereby referred to as “managed forests”, will therefore play key roles in the trade-off between provision of goods and maintenance of carbon stocks, biodiversity, and other services. However, so far, most of our understanding of tropical forests is based on studies carried out in old-growth undisturbed forests, or secondary forests (i.e. regrowth forests) while the ecology of degraded forests at the regional and continental scale remains poorly studied and their role to mitigate climate change still very poorly known. However, understanding the functions played by degraded forests in providing goods and environmental services in the context of climate change is crucial. We will first discuss the complex concept of forest degradation in the tropics and then define degraded forests. We will show their importance in providing timber while maintaining high levels of biodiversity and carbon stocks. We will further demonstrate that implementation of sustainable forest management can promote long term provision of ecosystem services. Finally, the potential of tropical degraded forests in mitigating climate change will be discussed along with future research challenges on this issue.

R&D efforts, coordination, and needs towards operational forest monitoring systems in the context of an increasing Earth observation data availability

B. Mora (1)
(1) GOFC-GOLD LC Project Office, Wageningen, Netherlands

Deforestation is the second largest source of anthropogenic greenhouse gas emissions to the atmosphere, accounting for 15% to 20% of the total emissions. To meet the challenge of climate change in the Agriculture, Forestry and Other Land Use (AFOLU) sector, the United Nations Framework Convention on Climate Change (UNFCCC) has been developing the Reducing Emissions from Deforestation and Forest Degradation (REDD+) mechanism. The UNFCCC recommends the use of remote sensing for forest monitoring in the frame of REDD++. Forest degradation can be monitored by remote sensing technologies using direct methods like forest gap detection, or indirect methods using logging road as a proxy. International initiatives such as the Global Observation for Forest Cover and Land Dynamics (GOFC-GOLD) and the Global Forest Observations Initiative (GFOi) of the Group on Earth Observations (GEO) foster sustainable availability of Earth observation data to support national forest monitoring and reporting activities compliant with the good practice guidance of the Intergovernmental Panel on Climate Change (IPCC). GOFC–GOLD and GFOi contributed to develop forest monitoring systems, with the REDD+ Sourcebook and the Method and Guidance Document, respectively. These international initiatives foster also coordinated research, as development of new model and systems encouraging joint projects between research institutions, in collaboration with space agencies.

The launch of Landsat–8 in 2014 ensures the continuity of Landsat missions with an increased ability to collect data compared to the 1980’s (about 14 times more images). Joint to the American effort, Europe will increase further Earth observation capacity with the Sentinel satellite constellations. Sentinel 1A was launched in 2014 with a Synthetic Aperture Radar C-band sensor. The launch of the Sentinel-2A carrying a superspectral optical sensor is scheduled for June 2015. Sentinel-2A will allow a coverage of the land surface every 10 days. Once Sentinel–2B will be launched, the Sentinel–2 satellites combined with Landsat–8 will allow a revisit time period of 3–4 days. Other national and international satellite missions will also provide or provide already additional imagery, either in the radar and optical domain (e.g., CBERS–4, SPOT series,
Assessment of forest degradation in the Amazon using multi-sensors techniques: the case of Paragominas (Brazil)

V. Gond (1) ; C. Bourgoin (1) ; L. Blanc (1) ; N. Baghdadi (2) ; J. Oszwald (3) ; P. Sist (4)
(1) CIRAD, ES, Montpellier, France; (2) IRSTEA, Umr tetis, Montpellier, France; (3) Université Rennes-2, Umr letg, Rennes, France; (4) Cirad, Montpellier, France

The Amazonian pioneer front region is a mosaic of different forests types and agricultural landscapes resulting from the colonization of the region through forest conversion into pasture and agricultural lands.

Fearnside and Guimaraes (1996) showed that 47% of the deforested area is rapidly deforested. It also appears that logged forests surface is equivalent to deforested areas (Asner et al., 2005).

Consequently a degradation gradient exists from low-impacted logged forests (depending of the logging intensity) to young secondary (regrowth) forests. To obtain more accurate estimation of carbon stocks, it is important today to take into account the degraded forest gradient including all degraded forest stages between mature intact forests and non-forest areas. The first main challenge is to identify and to characterize the various stages.

The study presents the first results obtained during the field work at Paragominas (Pará, Brazil) on different forest degradation intensities (Bérenguier et al., 2014). This field database is then compared with multi-sensors remote sensing to better understand multiple interactions and to establish a forest degradation typology.

The presentation will elaborate the state of play of REDD+ in the political context and discuss the approach and experiences of the Earth Observation and carbon monitoring community with the REDD political discussions. It addresses the research community with open scientific questions to improve methodologies to support REDD+ initiatives of forested communities, an example from central India, where local livelihoods are highly dependent on forests, illustrates the use of optical and radar data to monitor changes in forest biomass associated with human use. Loss of biomass is associated with human use surrounding villages. Reductions in degradation in this context depend on providing livelihood options that reduce dependence on forest resources. The utility of operational systems for monitoring progress towards that goal depends on the involvement of NGOs and other institutions working with local communities. Monitoring deforestation and forest degradation over large areas needs to account for the heterogeneity of forest types and varying pressures on forests in different settings.

Development of EO based national forest cover monitoring systems in the Congo Basin

C. Sannier (1) ; LV. Fichet, (1)
(1) SIRS SAS, Villeneuve d’Ascq, France

Deforestation is currently known to account for up to 20% of global greenhouse gas (GHG) emissions. Therefore, a significant decrease in deforestation can have a direct positive impact on reducing GHG emissions. Initiatives such as the Reduction of Emissions from Deforestation and Degradation (REDD), Low Emission Development Strategies (LEDS) or Zero Deforestation (ZD) aim to provide incentives to reduce deforestation. The Congo Basin represents the...
second largest forest area in the world after the Amazon. Deforestation in Congo Basin countries is generally expected to be low. The assessment of forest cover and forest cover change area is essential for the initiatives mentioned above to determine what is referred to as a high and low data in the Intergovernmental Panel on Climate Change (IPCC) 2006 guidelines on the Agriculture, Forestry and Other Land Use (AFOLU) sector.

Producing estimates of deforestation in tropical countries in relation to greenhouse gas (GHG) emissions often relies on the use of satellite remote sensing in the absence of National Forest Inventories (NFIs). A probability sample combined with an appropriate response design can provide forest cover and forest cover change area estimates and their associated uncertainties in the form of confidence intervals at a set probability threshold as recommended by the IPCC. In a paper, we present reanalysis and reference change simulations to the United Nations Framework Convention on Climate Change (UNFCCC). However, wall-to-wall mapping is often required by countries to provide an exhaustive assessment of their forest resources and as input to land use plans for management purposes, but implementing a wall-to-wall approach is expensive requiring specialized equipment and staff. The recent release of the Global Forest Change mapping products could provide an alternative for tropical countries wishing to develop their own wall-to-wall forest monitoring mapping products.

A model assisted regression (MAR) estimator was applied nationally in Gabon and for selected regions in Cameroon and CAR using the combination of both reference data obtained from a probability sample and nationally produced forest cover and forest cover change maps and produced from the Global Forest Change data. The resulting area estimate is potentially more accurate than the direct estimation and provides an estimate of the precision of the estimate which is not available from the map statistics alone.

Results show that the method presented provides a reliable means of producing forest cover and forest cover change area statistics and confirm the low level of deforestation expected in Congo basin countries. It also confirms the high level of forest cover and forest cover change with more than 85% of the country covered by forest covering an area of just over 23.5 million hectares. In Cameroon and CAR, forest represents about 72% of the area of the regions selected with a total of over 5 million hectares.

Forest cover estimates for national level maps lead to coefficients of variation less that 0.3% at national level in Gabon and between 1.8% at regional level in Cameroon and CAR thus reducing significantly the level of uncertainty for forest cover area estimates compared with reference data alone.

Deforestation rates are generally low, with less than 0.4% between 1990 and 2000 in Gabon. In CAR, the deforestation rate is about 1.5% between 1990 and 2000 and 0.8% between 2000 and 2010. However, the deforestation in Gabon is not statistically different from 0 between 2000 and 2010. The same is observed for the CAR regions. This is because the changes detected are very small and as a result the coefficients of variations of change estimates are greater.

Overall, results based on the global forest change data are not as accurate and precise and substantial post-processing and calibration are required to obtain results of similar quality than that of the national maps. However, it is also clear that the level of effort necessary would be considerably less than that for producing the national maps.

Will tropical forests face slow down with ongoing climate changes?

B. Hérault (1) ; M. Aubry-Kientz (2) ; V. Rossi (3) ; F. Wagner (4)

(1) Cirad, UMR EcoFoG, Kourou, French Guiana; (2) Université des Antilles et de la Guyane, Umr ecofog, Kourou, French Guiana; (3) Cirad, Ubrésef, Yaounde, Cameroon; (4) National Institute for Space Research, Remote sensing division, São José dos Campos, Brazil

In the context of climate changes, identifying and then predicting the impacts of climatic drivers on tropical forest dynamics is becoming a matter of urgency. We used a coupled model of tropical tree growth and mortality, calibrated with forest dynamic data from the 20 year study site of Paracou, French Guiana, in order to introduce and test a set of climatic variables. Three major climatic drivers of the tropical forest dynamics were identified through the variable selection procedure: drought, air temperature and precipitation. The three major climatic variables were investigated, showing best resistance to drought for trees with high wood density and for trees with small current diameters. We then used SEM, an individual-based model of tropical tree mortality and growth, to simulate for the next century using predictions from the IPCC A1B and A1B scenarios corresponding to 3 concentration pathways. Basal area, above-ground forest biomass and forest cover area estimates were produced from the Global Forest Change data. The resulting area estimate is potentially more accurate than the direct estimation and provides an estimate of the precision of the estimate which is not available from the map statistics alone.

Results show that the method presented provides a reliable means of producing forest cover and forest cover change area statistics and confirm the low level of deforestation expected in Congo basin countries. It also confirms the high level of forest cover and forest cover change with more than 85% of the country covered by forest covering an area of just over 23.5 million hectares. In Cameroon and CAR, forest represents about 72% of the area of the regions selected with a total of over 5 million hectares.

Overall, results based on the global forest change data are not as accurate and precise and substantial post-processing and calibration are required to obtain results of similar quality than that of the national maps. However, it is also clear that the level of effort necessary would be considerably less than that for producing the national maps.

AMAZONIA, A TROPICAL FOREST IN TRANSITION: FROM NATURAL BIOMASS TO LAND USE CHANGE, LARGE SCALE BIOMASS BURNING AND URBANIZATION

P. Artaxo (1); H. Barbosa, (1); JF. Brito, (1); S. Carbone, (1); E. Sena, (1); L Rizzo, (2)

(1) University of São Paulo, Applied Physics Department, São Paulo, Brazil; (2) Federal University of São Paulo, UNIFESP, Department of Earth and exact sciences, Diadema, Brazil

Amazonia is a large tropical forest in transition, with strong pressures for agriculture expansion, climate change, urbanization and others. Deforestation rate has decreased dramatically from 2.7 million hectares in 1980-1990 to 0.9 million hectares in 2013, being responsible for a strong reduction in greenhouse gas emissions on the order of 70%. Agricultural expansion and climate variability have become important agents of disturbance in the Amazon basin. Recent studies have demonstrated considerable resilience of Amazonian forests to moderate annual drought, but they also show that interactions between deforestation, fire and drought potentially lead to losses of carbon storage and changes in regional precipitation patterns and river discharge. Although the basin-wide impacts of land use and drought may not yet surpass the magnitude of natural variability of hydrologic and biogeochemical cycles, there are some signs of a transition to a disturbance-dominated regime. These signs include changing energy and water cycles in the southern and eastern portions of the Amazon basin.

Feedbacks in Amazonia are very strong between ecosystem functioning, trace gases and aerosol emissions, cloud cover, precipitation, radiation balance and other key issues. In the wet season, a large portion of the Amazon region constitutes one of the most pristine continental areas, with very low concentrations of atmospheric trace gases and aerosol particles. However, land use change modifies the biota-atmosphere interactions in such a way that key processes that maintain the functioning of Amazonia are substantially altered. This study presents long term aerosol and trace gas observations in a preserved forest site in Central Amazonia, with observations from 2008 to 2013. Amazonian aerosols were characterized in detail, including aerosol size distributions, aerosol light absorption and scattering, optical depth, and trace gas observations at a preserved forest site in Central Amazonia, with observations from 2008 to 2013. Amazonian aerosols were characterized in detail, including aerosol size distributions, aerosol light absorption and scattering, optical depth, and trace gas observations at a preserved forest site in Central Amazonia, with observations from 2008 to 2013. Amazonian aerosols were characterized in detail, including aerosol size distributions, aerosol light absorption and scattering, optical depth, and trace gas observations at a preserved forest site in Central Amazonia, with observations from 2008 to 2013.

Trace gases analyzed includes volatile organic compounds (VOCs), O3, CO2, CH4, N2O and CO. The central Amazonia region showed very low concentrations of PM1 aerosol (1.0 ± 0.7 µgm–3 and 3.4 ± 2.0 µgm–3 in the wet and dry seasons, respectively), with a median particle number concentration of a low 220 cm–3 in the wet season. Aerosol composition showed a high degree of organic composition, among others properties. Trace gases analyzed includes volatile organic compounds (VOCs), O3, CO2, CH4, N2O and CO. The central Amazonia region showed very low concentrations of PM1 aerosol (1.0 ± 0.7 µgm–3 and 3.4 ± 2.0 µgm–3 in the wet and dry seasons, respectively), with a median particle number concentration of a low 220 cm–3 in the wet season. Aerosol composition showed a high degree of organic composition, among others properties. Trace gases analyzed includes volatile organic compounds (VOCs), O3, CO2, CH4, N2O and CO. The central Amazonia region showed very low concentrations of PM1 aerosol (1.0 ± 0.7 µgm–3 and 3.4 ± 2.0 µgm–3 in the wet and dry seasons, respectively), with a median particle number concentration of a low 220 cm–3 in the wet season. Aerosol composition showed a high degree of organic composition, among others properties. Trace gases analyzed includes volatile organic compounds (VOCs), O3, CO2, CH4, N2O and CO. The central Amazonia region showed very low concentrations of PM1 aerosol (1.0 ± 0.7 µgm–3 and 3.4 ± 2.0 µgm–3 in the wet and dry seasons, respectively), with a median particle number concentration of a low 220 cm–3 in the wet season. Aerosol composition showed a high degree of organic composition, among others properties. Trace gases analyzed includes volatile organic compounds (VOCs), O3, CO2, CH4, N2O and CO. The central Amazonia region showed very low concentrations of PM1 aerosol (1.0 ± 0.7 µgm–3 and 3.4 ± 2.0 µgm–3 in the wet and dry seasons, respectively), with a median particle number concentration of a low 220 cm–3 in the wet season. Aerosol composition showed a high degree of organic composition, among others properties.
Remote sensing observations from six AERONET sites and MODIS data were used to provide a regional and temporal overview of changes in Amazonian atmosphere. Aerosol Optical Depth (AOD) at 550 nm of less than 0.1 is characteristic of natural conditions over Amazonia. At the tropical rainforest regions in which values greater than 4 were frequently observed in the dry season. Combined analysis of MODIS and CERES showed that the mean direct radiative forcing of aerosols at the top of the atmosphere (TOA) during the biomass burning season was high at 5.6±1.7 Wm−2, averaged over whole Amazon Basin. For high AOD (larger than 1) the maximum of the direct radiative forcing at the TOA was as high as −20 Wm−2. This change in the radiation balance caused increases in the diffuse radiation flux, with an increase of Net Ecosystem Exchange (NEE) of 18–29% for high values of AOD. Recently the GoAmazon project is analyzing the impacts of aerosol radiative properties on atmospheric properties. Preliminary results show important changes in ozone formation, secondary organic aerosol production and cloud properties.

From this analysis, it is clear that land use change in Amazonia shows alterations of many atmospheric properties, and these changes are affecting the functioning of the Amazonian ecosystem in significant ways. The potential impacts on global carbon cycle and on the hydrological cycle are large.

Funded by Instituto Nacional de Ciencia e Tecnologia para Mudancas Climaticas – INCT Global Change – CNPq/ FAPESP, and FAPESP project 2013/05140-0

P-2215-02

Climatic implications of forest transformation in Nigeria: quantitative and qualitative approaches

S. Ayanlade (1)
(1) Obafemi Awolowo University, Ile-Ife, Nigeria, Dept. of Geography, Ile-Ife, Osun, France

This study examines forest transformation in the rainforest of Nigeria, focusing on the drivers of forest change, the climatic and societal implications on the local people. Both quantitative and qualitative approaches were used. Remote sensing was used to perform quantitative analysis while social methods were used as qualitative approaches to evaluate the spatial and temporal rate of deforestation. A time series of Landsat data was used over the period from 1984 to 2011. Remote sensing changes in land use and forests were used transformation in forest reserves in the study area. Two forest reserves, Okomu and Sakponba/Urhonigbe, were examined to have clear case studies of intensified deforestation. The implications of these changes on local climate around the forest reserves were assessed. Social survey data, questionnaires and interviews, were used to assess societal implications of forest transformation on local people in the study area. Ancillary data such as population data, road network data, and climate data were used to assess the drivers of forest transformation and their implications. Correlation analysis was performed to assess the relationship between deforestation and population, road network, and area temperature around the forest reserves. The results show that deforestation and forest reserve area cover loss are 90%. There are good relationships between deforestation and distance from road (R2= 0.52), also between high diversity of tropical forests and its area cover while Sakponba/Urhonigbe forest reserves loss about 90%. There are good relationships between deforestation and road networks (R2= 0.48). There appears to be a significant relationship between change forest cover and surface temperature with R2= 0.46. Thus, the major finding of this study is that deforestation is a major cause of the result of increased accessibility created by road network. Forest reserve with high rate of road accessibility has high rate of deforestation compared to the forest reserve with less road accessibility. The results suggest that increased population appears to be driving people to access these forest areas, that the relationship between population and deforestation relatively significant. The major implication of deforestation on local climate is that a major cause of deforestation in the rainforest of Nigeria is the increased accessibility created by road network. Forest reserves with high rate of road accessibility have high rate of deforestation compared to the forest reserve with less road accessibility. The results suggest that increased population appears to be driving people to access these forest areas, that the relationship between population and deforestation is relatively significant. The major implication of deforestation on local climate is that a major cause of deforestation in the rainforest of Nigeria is the increased accessibility created by road network.
Our methodology is a novel tool to accurately predict long-term ecological consequences in Congo Basin forests under both constraints of climate change and selective logging. One of the main immediate applications would be to check if classical SFM strategies, such as Reduced Impact Logging (RIL) or Improved Forest Management (IFM) or poses logging Sylviculture, are still valid when the ecological complexity and the climate sensitivity of tropical forests are duly taken into account. As an envisaged development, a coupling with a logging cost model could allow for predicting climate change impact on the economics of forest-based sectors, including tax revenues and socio-economic local benefits. More generally, our work could contribute to the improvement of climate-smart policies for Central African forests, a critical issue in the current context of deployment of the mechanism of Reducing emissions from deforestation and forest degradation and the role of forest conservation in the management of forests and enhancement of forest carbon stocks in developing countries (REDD+).

The AmazonFACE research program: assessing the effects of increasing atmospheric CO2 on the ecology and resilience of the Amazon forest

Dos Santos Capol (1); CAN. Quesada (2); RJ. Norby, (3); AC. Araujo (4); T. Dounglang (5); L. Hartley (6); B. Kruijt (7); K. Lewin (8); P. Meir (9); A. Rammig (10); A. Walker (11); J. Ometto (12)

Despite being suggested, for nearly 20 years now, as a process of utter importance for the resilience of the Amazon forest and maintenance of the global carbon cycle, the issue of CO2 fertilization on tropical forests remains largely underdetermined. Reducing this uncertainty is critical to the future of the Amazon region as well as for the understanding of critical interactions with environment to climate change. In this presentation we will introduce the AmazonFACE (Free-Air CO2 Enrichment) research program, an experiment of unprecedented scope and importance in a primary, old-growth forest of the Amazon basin near Manaus, Brazil – the first of this kind in a tropical forest. The experiment will simulate an atmospheric CO2 composition of the future in order to help answer the question: “How will rising atmospheric CO2 affect the resilience of the Amazon forest, the biodiversity it harbors, and the ecosystem services it provides in light of projected climate changes?” AmazonFACE is divided in three phases: (i) exploratory; (ii) experimental; and (iii) long-term experiment comprised of four pairs of FACE plots maintained at ambient or elevated CO2 concentrations for 10 years (Dec 2017-Sept 2027). The forests inside the FACE chambers will be scientifically scrutinized from the top-most canopy leaves to the deepest roots in terms of carbon metabolism and cycling, water use, nutrient cycling, forest community composition and interactions with external stressors. A multi-disciplinary team of scientists namely from Brazil, USA and Europe will employ state-of-the-art tools from deep in the soil to above the forest canopy. The resulting data sets will be valuable resources for a broad community of scientists, especially for ecosystem and climate modelers.
Agronomie pour le Développement, Tunis, Tunisia; (8) Universidade do Estado da Bahia, Senhor do Bonfim, Brazil; (9) Fundação Cearense de Meteorologia e Recursos Hidricos, Fortaleza, Brazil

Although the Northeast Brazil is mainly characterized by a semi-arid climate that corresponds to the driest area of Brazil, a sub-humid climate persists in small mountainous areas close to the coast. Such very local climatic conditions enable the establishment of a highly diversified Neotropical rainforest that represents rainforest microrefugia surrounded by a xeric shrubland and thorn forest. Because these microrefugia are characterized by small areas with specific vegetation and microclimatic conditions, their potentials to sustain tropical biodiversity are generally underestimated within the future scenarios of climate change. In order to characterize the different communities and distributions of the rainforests and the present-day pollen rain in soil samples along an altitudinal gradient for several microrefugia from Northeast Brazil. We identified several ecological successions characterized by the succession and distribution of species. The distribution depends on water availability linked to several factors (e.g., elevation, slope, distance from the coast). To test their potential to sustain future tropical biodiversity we compared our calibration of pollen rain with fossil pollen data in one of these microrefugia. Despite the high sensitivity of rainforest to climatic variability evidenced by our study, we observed a very slow response to past climate changes by recruiting key species among its highly diverse stock. Our results suggest that the high plant diversity of the microrefugium could play an important role in allowing adaptation of specific assemblages in response to different climatic conditions. Consequently, we demonstrate that identification and conservation of such microhabitats in the context of future climate change represent a crucial interest in policing the tropical biodiversity.

P-2215-07
Congo Basin forests under pressure: the role of increasing population and strong international palm oil demand
A. Mosnier, (1); J. Pirker (1); G. Boccuque, (1); R. Mant (2); B. Bodin, (2); D. Bokelo, (3); A. Makoudjou, (3); N. Ndinga, (3); P. Tonga, (3); P. Hadfield (2); M. Obersteiner (1)

The Congo Basin forest is the second largest rainfall area after the Amazon rain forest. The area has been relatively preserved up to now. However, pressure on the Congo Basin forests is increasing with high population growth, which is linked to changes in land use, climate change, and deforestation. The challenges the region will face to protect its forests and ensure economic development. We compute emissions from future land use change and test their sensitivity to several model parameters including future population, economic growth, and land carbon content from different sources (IPCC, FAO–FRA, NASA and WHRC).

From our results, deforestation over the next decades increases strongly in the Congo Basin: the average annual deforested area is 60% higher over 2010–2020 and 123% higher over 2020–2030 compared to the historical rate 2000–2010. The palm oil production over 2000–2030 and also more than double exports but a high share of the total production is used to satisfy rapidly increasing domestic needs. More generally, we observe that if Laurisilva coniferous forest is present in the Congo Basin is mainly driven by internal demand. The Democratic Republic of Congo and Cameroon will experience the highest pressure from the agricultural sector while in the Republic of Congo and CAR, deforestation is mainly driven by timber exploitation. Since uncertainties in the carbon content of the forest land are quite important in the region, they lead to significant variations of emissions from deforestation in our computation. The Congo Basin countries represent an important challenge for the REDD+ framework as i) historical deforestation rate is not very indicative to estimate carbon change and ii) neither carbon fluxes due to deforestation nor forest carbon stocks are not accurately assessed. Thus, we propose a carbon assessment for three countries –Cameroon, the Republic of Congo and the Democratic Republic of Congo– to illustrate the variety of challenges the region will face to protect its forests and ensure economic development. We compute emissions from future land use change and test their sensitivity to several model parameters including future population, economic growth, and land carbon content from different sources (IPCC, FAO–FRA, NASA and WHRC).

P-2215-08
Estimating and Forecasting Carbon Stocks in Indian Tropical Forests using the LiDAR Technology
F. Munoz (1); M. Réjou-Méchain (1); N. Ayyappan (1); C. Véga, (1); J. Morel, (1); P. Grard (1)

(1) French Institute of Pondicherry, Pondicherry, India

Tropical forests play a major role in the cycle of terrestrial carbon, being at the same time both sinks and sources of atmospheric CO2. It is estimated that around 40% of forest carbon is contained in the above-ground biomass of trees, the stock of which, at the global scale, varies mainly through reforestation and deforestation. Monitoring the stocks of forest biomass is therefore a major issue for the reduction of uncertainties associated with the overall assessment of carbon in forest carbon inventories. International institutions are therefore increasingly demanding for an effective decrease in the uncertainties associated with the estimation of these stocks. The conferences of the United Nations Framework Conventions on climate change, the next one of which will be held in Paris in 2015 (COP21), have as a main objective to reduce greenhouse gas emissions in order to limit global warming. Each country is invited, on a voluntary basis, to quantify the stocks of forests in order to report about their territory. In south and south-east Asia, huge progress has been made in this area in the past decade, with good level research and technical competencies. However, the quality of works remains variable, and the efforts are made at the national scale with very little exchanges of knowledge and know-how between institutions of different countries. This isolation considerably limits the emergence of international standards in the monitoring of these stocks. Developing new methods for monitoring forest carbon, widening ongoing works and stimulating exchanges of knowledge and know-how with regard to the monitoring of forest carbon stocks is therefore one of the main objectives of the French Institute of Pondicherry (FIP) in South India. The emergence of methodologies that capitalize on the products of remote sensing in their territory. In south and south-east Asia, this approach has been partially achieved in countries like Malaysia, Thailand, Indonesia, and the Philippines where the mapping of forest biomass via remote sensing tools is therefore mostly driven by foreign investments and supported by the States are also flourishing in the region to take opportunity of growing international demand. Global palm oil production has more than doubled over the last decade and ambitious palm oil production targets are now included in the development strategy of the Congo basin countries.

We use the land use economic model CongoBIOM to explore projections of future land use in the Congo Basin, including the role of shifting agriculture and plantation expansion. CongoBIOM is an agro-economic model that links land-based activities and land use changes at a 50x50km resolution level. It includes domestic and international demand for crops, livestock products and wood products. In CongoBIOM, models of the transformation from forest conversion to both subsistence and intensive agriculture and also from intensive fuel wood harvests. Forest degradation is caused by logging activities. We have built a global oil palm suitability map to improve the model representation of future oil palm expansion. Results are presented for the whole Congo Basin and in more details for three countries –Cameroon, the Republic of Congo and the Democratic Republic of Congo– to illustrate the variety of challenges the region will face to protect its forests and ensure economic development. We compute emissions from future land use change and test their sensitivity to several model parameters including future population, economic growth, and land carbon content from different sources (IPCC, FAO–FRA, NASA and WHRC).
inconsistencies are sometimes of the same order of magnitude indicating the limits of the maps. During the past few years, the FIP has invested a great deal in the processing of remote sensing data, and in particular of the data generated by the very promising LiDAR technology (airborne or terrestrial laser). These new technologies allow unprecedented measures of forest structures with a centimetre–level resolution through entire landscapes. Furthermore, the FIP has monitored forest dynamics in permanent forest plots at Uppangala, in the Western Ghats biodiversity hotspot, for more than 20 years. Coupling detailed information on forest dynamics with airborne and terrestrial LiDAR data opens promising perspectives to understand and forecast with high precision the ability of tropical forests to stock carbon. For these reasons their evolution in response to both human pressure and climate change is critical. As compared to the Amazonian and Asian rainforests, the rainforest of Central Africa experiences slower deforestation rates, so that its main threat for the next decades consists in the risk of carbon emissions. So far, the response and sensitivity of the Central Africa rainforest to the mean seasonal evolution and inter-annual variability of climate has attracted little interest. Indeed, most of the studies focus on its Amazonian counterpart and suggest that solar irradiation is the main driver of the annual and inter-annual variations of rainforest photosynthetic activity, and the Central Africa climate itself is not well documented.

As a first step towards a better understanding of the Central Africa rainforest sensitivity to present–day climate variability and response to climate change, this study performs for a target region located between 0–5°N/12–19°E (thus documenting forest areas from 5 countries) and using space borne observations, a detailed analysis of the rainforest photosynthetic activity mean seasonal cycle, comparing it with those of climate variables considered as potential drivers, i.e. rainfall, cloudiness and solar irradiation.

Several key points emerge from our study. First, the seasonal cycles of photosynthetic activity (EVI MODIS) and rainfall over our target region are both bimodal. However, the highest peak of EVI (March–May) coincides with the driest of the two rainy seasons while the lowest peak of EVI (September–October) coincides with the wettest of the two rainy seasons. Second, the two rainy seasons are not associated with two distinct lows in total solar irradiation and two distinct peaks in total cloudiness: the first rainy season (March–May) which is less rainy as compared to the second one (September–October) and receives more total solar irradiation. This might explain the higher EVI values recorded. Third, the high total cloudiness recorded throughout the seasonal cycle actually hides marked seasonal variations in the frequency of the 5 main types of clouds analyzed. These cloud types have specific diurnal cycles which control those of solar irradiation (thus the daily light and energy available for photosynthesis), but also influence the remote sensed photosynthetic activity data (or index).

Our results clearly show that (1) nor the two dry seasons, nor the two rainy seasons do compare in terms of rainfall, cloudiness, solar irradiation and temperature, and (2) water and light availability have a respective weight in the Central Africa rainforest photosynthetic activity which evolves throughout the seasonal cycle. They also suggest that any evolution, due to climate change, of the complex diurnal cycles of rainfall, nebulosity and solar irradiation which characterize the equatorial climate regimes might perturb the forest photosynthetic activity and enhance these ecosystems vulnerability.

**P-2215-09**

**GHG emissions and mitigation – a model approach for the Brazilian Amazon**

J. Ometto (1) ; AP. Aguiar, (1) ; LA. Martinelli, (2) ; M. Bustamante (3) ; T. Assis, (1) ; ED. Nora, (1) ; FS. Pacheco, (1) ; (1) National Institute for Space Research (INPE), Earth system science centre, Sao Jose dos Campos, Brazil; (2) University of Sao Paulo, Center for nuclear energy in agriculture, Piracicaba, Brazil; (3) Universidade de Brasilia, Departamento de ecologia, Brasilia, Brazil

According to the recent scientific literature on the field, about 70% of the terrestrial sink of CO2 derived from anthropogenic activities resides in tropical forests. Of the tropical belt, the South America Amazon encompasses the largest continuous broadleaf forest in the globe. Estimates accounts more than 50% of the tropical carbon sink to these forests. Tropical deforestation accounts from about 1/10th to 1/5th of the global anthropogenic emissions of carbon and carbon equivalent green house gases. Big uncertainties associated to these estimates rely on the quantification of forested areas in tropical forests and its spatial distribution. Adding up to the uncertainty on carbon emission estimates, the deforestation is not a linear process, but a patchy activity in the landscapes, characterized by dynamic processes in both spatial and temporal dimension. Thereby, studies on carbon sources, sinks and stocks are urgent observational needs for both remote and ground observation in the tropics.

This paper will present recent studies coupling observation, remote and modeling approaches to better estimate greenhouse gases emissions from tropical deforestation, with special focus on the Amazon forest. The result present outcomes of the INPE–EM model, developed at the National Institute for Space Research, in Brazil. The spatially explicit model incorporates the deforestation dynamics, the biophysical and socioeconomic heterogeneity of the region. As well, work will explore mitigations of greenhouse gases emissions within a cost framework, processes associated to nutrient use and emissions of nitrous oxide.

**P-2215-10**

**Contribution of the analysis of diurnal cycles for understanding the mean seasonal cycle of rainforest photosynthetic activity in Central Africa**

N. Philippin (1) ; B. De Lapparent (1) ; V. Gond (2) ; S. Bigot (3) ; T. Brou, (4) ; P. Camberlin, (1) ; G. Cornu, (2) ; V. Derren (3) ; N. Martiny, (1) ; B. Morel, (6) ; V. Moron (7) ; G. Sèze, (8)

(1) Centre de Recherche de Climatologie, Biogéosciences UMR6282 CNRS / UB, Dijon, France; (2) CIRAD, ES, Montpellier, France; (3) Laboratoire d'Études des Transferts en Hydrologie et Environnement (LTHE), Université Grenoble Alpes, Grenoble, France; (4) UMR 228 ESPACE–DEV (IRD, UM2, UAG, UR), Saint Denis, France; (5) LETG-Rennes; (6) Centre de Recherches en Hydrologie Théorique et Environnementale (CRHTE), Université de Rennes 2, Rennes, France; (6) LE2P, EA 4079, Université de La Réunion, Saint Denis, France; (7) Aix–Marseille Université, CEREGE UM 34 CNRS, France, Geography, Aix–en–Provence, France; (8) LMD, UMR8539 CNRS / Université Paris 6, Paris, France

Global carbon, water and energy cycles are substantially driven by vegetation phenology. In particular tropical rainforests have been shown to be a key component of the climate system as they act as major water vapor sources and carbon dioxide sink. For these reasons their evolution in response to both human pressure and climate change is critical. As compared to the Amazonian and Asian rainforests, the rainforest of Central Africa experiences slower deforestation rates, so that its main threat for the next decades consists in the risk of carbon emissions. So far, the response and sensitivity of the Central Africa rainforest to the mean seasonal evolution and inter-annual variability of climate has attracted little interest. Indeed, most of the studies focus on its Amazonian counterpart and suggest that solar irradiation is the main driver of the annual and inter-annual variations of rainforest photosynthetic activity, and the Central Africa climate itself is not well documented.

As a first step towards a better understanding of the Central Africa rainforest sensitivity to present–day climate variability and response to climate change, this study performs for a target region located between 0–5°N/12–19°E (thus documenting forest areas from 5 countries) and using space borne observations, a detailed analysis of the rainforest photosynthetic activity mean seasonal cycle, comparing it with those of climate variables considered as potential drivers, i.e. rainfall, cloudiness and solar irradiation.

Several key points emerge from our study. First, the seasonal cycles of photosynthetic activity (EVI MODIS) and rainfall over our target region are both bimodal. However, the highest peak of EVI (March–May) coincides with the driest of the two rainy seasons while the lowest peak of EVI (September–October) coincides with the wettest of the two rainy seasons. Second, the two rainy seasons are not associated with two distinct lows in total solar irradiation and two distinct peaks in total cloudiness: the first rainy season (March–May) which is less rainy as compared to the second one (September–October) and receives more total solar irradiation. This might explain the higher EVI values recorded. Third, the high total cloudiness recorded throughout the seasonal cycle actually hides marked seasonal variations in the frequency of the 5 main types of clouds analyzed. These cloud types have specific diurnal cycles which control those of solar irradiation (thus the daily light and energy available for photosynthesis), but also influence the remote sensed photosynthetic activity data (or index).

Our results clearly show that (1) nor the two dry seasons, nor the two rainy seasons do compare in terms of rainfall, cloudiness, solar irradiation and temperature, and (2) water and light availability have a respective weight in the Central Africa rainforest photosynthetic activity which evolves throughout the seasonal cycle. They also suggest that any evolution, due to climate change, of the complex diurnal cycles of rainfall, nebulosity and solar irradiation which characterize the equatorial climate regimes might perturb the forest photosynthetic activity and enhance these ecosystems vulnerability.

**P-2215-11**

**Bhabar Terai Forest Cover Reduction Causes Climate Change in the North Bank of the Brahmaputra Valley increased Severity in Flood**

BP. Saikia (1)

(1) Gauhati University, Centre for animal ecology and wildlife biology, department of zoology, Guwahati, India

During the last few decades floods in the Brahmaputra basin had been extremely of large magnitude and high frequency and there were heavy floods in Assam almost every alternate year. The fragile hills of the Himalayan Mountain range are prone to major landslides that are getting aggravated due to wide ranging deforestation, mismanagement in the catchment, rampant construction of embankments and roads and cutting in the Brahmaputra basin.

We have examined the decadal change in the forest cover of the Brahmaputra basin from 1970–80’s to 2010 and compared with the increase in the level of flood severity, frequency and increasing level of the rising temperatures from the existing data set and field survey on the North Bank of the river Brahmaputra.

During the period of the study this has been found that the decreasing forest cover has major role in the rising temperature and flood. On the entire North Bank of the
River Brahmaputra on the foothills of Himalaya there have specializations of Bhabar Terai forest. This has been seen that where these Bhabar–Terai zone has been removed from the foothill the severity of the flooding has been increased with the decadal rise of temperature in such areas. This intense rainfall has found increasing in the last four decades but the number of the rainy days has been decreasing.

After the 1950 earthquake and following flood in the year 1954 the entire basin of the Brahmaputra river changed forever. With the many fold increase of human population in the Brahmaputra valley the conversion of the forest land into agricultural lands started in a faster rate and continued till the 1996 Supreme Court ban on the timber logging and any such activity. Along with this forest destruction the flood occurrence in the Brahmaputra basin has been observed from the year 1964, '66, '72, '74, '77, '78, '84, '86, '87, '88, '89, '90, '91, '92, '93, '94, '95, '96, '97, '98, '99, 2000, 2011, 2012 and 2013 and is still continuing. It has been revealed from the present study that the magnitude increased with time and frequency of flood increased which direct positive correlation with the decadal rise in temperature and negative correlation with the decadal forest cover change in the North Bank of the river Brahmaputra in Assam specially the Bhabar and Terai forest which acts as the cushion for the speeding rainwater on the foothills zone of the Himalaya in the basin. It has been revealed from the present study that forest cover in the foothills zone are very much necessary for resisting the impact of climate change such as increasing temperature, rainfall and flood. Hence, the forest cover has been necessarily found related with the severity of flood thus helps in curbing climate change impact.

Forest carbon conservation and management for multiple resource values and ecosystem services

JL. Peyron (1) ; A. Sample (2)
(1) ECOFOR, PARIS, France; (2) Pinchot Institute for Conservation, Washington, United States of America

Forest carbon management is an important consideration in temperate forests as well as tropical forests. It is estimated that US forests absorb up to 5 percent of total US greenhouse gas emissions. A recent research suggests that this net carbon sink is declining, and that US forests could become a net carbon source within the next few decades unless decisive action is taken in the near term to alter this trajectory. Annual per capita carbon emissions in the US are triple those of France, and more than eight times those of Brazil or Indonesia, so many in the US forestry community consider it a moral responsibility to avoid this possible future. This paper will summarize ongoing research to determine whether forest management is compatible with forest resource sustainability (continued production for a variety of goods and services), and whether forest carbon management enhances or detracts from other ecosystem services such as water and biodiversity. Examples are drawn from private forest lands managed primarily for timber and other economic values, and from public forest lands in which management for specific forest uses, values, and services are mandated by law or policy.

Understanding and directing small-scale private forest owner behaviour towards climate change adaptation

U. Pröbstl-Haider (1) ; R. Jandl (2) ; H. Formayer, (1) ; M. Suda, (3) ; W. Haider (4) ; N. Mostegel (1)
(1) University of Natural Resources and Life Sciences Vienna, Vienna, Austria; (2) Forest Research Center, BFW, Vienne, Austria; (3) Technical University of Munich, Munich, Germany; (4) Simon Fraser University, Burnaby, Canada

Climate change will affect many productive forests across Austria, which may lead to significant economic loss, but also depicts various opportunities for future management. While the Federal Forest Service already takes climate change into account, little is known about adaptation of small-scale private forest owners, who manage 56% of Austria’s forests. Consequently, this project will investigate human dimensions of climate change and small-scale forest owners’ adaptation strategies. The main focus lies on their climate change perception, ways to influence their implementation of adaptation methods, the rising of their awareness of possible risks of inactivity, and the enhancement of their transition to resilient forests. The key challenge is to “re-interest” this group in their property and to increase the awareness of their required contribution. For this purpose, the project develops innovative concepts for attracting as many forest owners...
as possible to implement adaptive measures. The core of this study builds a questionnaire combined with a discrete choice experiment, which aims at acquiring a thorough understanding of the salient factors influencing decision-making processes. This innovative methodologically approach initially combines forest growth modeling and visualization of potential effects within a stated preference method.

**O-2216-02**

**How forests can support adaptation of landscapes systems to mitigate climate change? A landscape approach to sustainable forest management**

S. Luque (1)

(1) IRSTEA – National Research Institute of Science and Technology Environment and Agriculture, Mountain ecosystems, Grenoble, France

The world’s forests are in a state of flux due to land-use and climate change, deforestation, afforestation, wildfires, insects and pathogen outbreaks. In the face of both anthropogenic and natural forces there is an increasing need to assess the value of our forests. The interconnection between the ecosystem service (ES) concept and the framework of forest management stems from a need to create a more holistic perception of forests, recognizing not only their economic value, but also their cultural and ecological values including their regulation capability. Thus, requirements of an optimized forest production and an environmental quality improvement represent a true challenge for the years to come. A fast reorganization of the forest sector is needed in order to find the right balance between management within a forest ecosystem services approach at different scales. In particular, we need to consider a valorisation of wood resources and production, thorough knowledge of their vulnerability within an intensification management scenario.

As climate changes, societal demands for goods and services from forests are also changing. The recent decision of European government leaders to increase the share of renewable energy in Europe to 20% by 2020 is expected to result in a much higher demand for forest biomass for bio-energy generation. This higher demand will intensify the competition for resources between forest industry, the energy sector, and nature conservation/other protective functions and services (including biodiversity, protection from natural hazards, landscape aesthetics, recreation and tourism and climate regulation). A comprehensive and integrative approach from the plot level to the landscape level is needed through collaborative tools. Such tools also should inform on what level of spatial scale adaptation measures can be effective: can they just do it by managing the land within their jurisdiction, or are they dependent on changes at broader scales and do they need to collaborate with other land managers around? Scenario analysis and planning options for the future will be also presented based on specific case studies as exemplars. The work opens questions regarding the needs for a comprehensive adaptive forest management under changing environmental conditions to improve forest management in a wide range of territories.

The challenge that lays ahead demands gaining awareness of the increasing pressures on forests and forest resources and concern about the continuous changes in climate conditions that will increase forest degradation forest-wood product chain in terms of sequestration and substitution of carbon when we account for forest response to climate change and consequent forest managers adaptations; (2) assess the effects of the incertitude of current climate scenarios on the above carbon balance; (3) assess the potential consequences of an early introduction of adaptation measures.

**Methodology:** We use a spatially-explicit bio-economic Model of the French Forest Sector (FFSM++) that is able to consider and integrate: (a) effects of climate change over forest dynamic; (b) forest investment decisions (among groups of species) according to expected profitability (c) market effects on carbon and wood products; (d) variations of species impact on the forest carbon balance, that however tends to peak in about 100 years. In A2 and B1 scenarios the forest balance decreases by 0.51% and 1.20% respectively. Testing 12 different climatic models for the A1B scenario we obtain a coefficient of variation of 2.47% for the overall carbon balance. Allowing forest managers to have a perfect foresight on future climate favour broadleaved species but has a limited effect on the carbon balance.

**2216-POSTER PRESENTATIONS**

**P-2216-01**

**Community based Climate Change Adaptation: A Case of Community forestry programme in Nepal**

NK. Bk (1)

(1) Kathmandu University, Department of Development Studies, Kathmandu, Bagmati , Nepal

Community forestry programme is a major community based climate change adaptation (BCCA) and potential mitigation strategy; recognized by climate change policy and national adaptation program (PROADAPT) of Nepal. In these regards, some community forestry user groups (CFUGs), in the support of donor organizations , are implementing practices of community based adaption plans (CBAPs) for addressing climate change and its impacts on wider socio-economic development of vulnerable community.

Based on the paper presenter’s 10 years long experience in the issues and the study of six community forest user groups, three from each of DFID/UK and CARE supported groups, the finding shows that the programme is suitable mechanism for planned, decentralized, cost effective, limited and inclusive adaptation strategies. The programme is initiated and groups are formed to address the issues of natural hazards and mal-adaptation practices the local people followed previously in responses to local changes. The groups adopt bottom up planning process to identify vulnerability and prepare adaption plan, collaborative effort to establish matching fund to implement prioritized activities and coordinating mechanism to integrate these activities into wider development programmes of local areas. These practices increased the livelihoods security of marginal groups through increasing human and food security and forest product availability, building social capitals, use of indigenous knowledge and skills, as well as some practices linked to the landless poor members, and deriving benefits from development service providers.

While community forestry policies and practices of Nepal seem climate change friendly exclusions persists and people who are member of the groups have opportunity...
to get benefit from the adaptation fund while there are some households/communities are excluded from the groups. Also, limitation on extraction of forest products is in some instances undermining the livelihood strategies of the forest dependant people limiting their adaptation capacity. The community forestry user groups have established resource distribution system based on wealth ranking of the groups, the mitigation strategies specifically the REDD mechanism may be of the poor category of the users. However, we find that the executive committees of CFUGs are politicized and the policy affects resource distribution. Also, there are high value forest trees, the illegal sale of which offers considerable financial intensives. So, particularly in the Terai, the conservation and regeneration of forest depends on the cost of forest and high opportunity costs. Also, there are significant issues of land tenure conflicts between people and Government, VDCs (Village Development Committee), and communities, the result of which does not favor the protection, management and conservation of forest.

The findings suggest that CBCCA approach needs to extend in rural development policies at landscape level. As the groups are growing as a local adaption funding institutions, the role of CFUGs should be linked with low carbon and high-interested low-loans. To increase the community forestry for mitigation, climate change sensitive forest management guidelines needs to developed and linked with national forestry activities. In addition, there is a need for CFUGS (Pay for services) and carbon markets more broadly than strictly REDD mechanism; Community forestry stakeholders should undertake experiential marketing of forest carbon in a volunteer market.

P-2216-02

Disentangling the climate change contributions of CO2 emissions from global forest bioenergy

F. Cherubini (1)
(1) Norwegian University of Science and Technology (NTNU), Trondheim, Norway

Many future energy and emission scenarios envisage an increase in bioenergy production in the global primary energy mix [1]. Bioenergy is the most important renewable energy option in studies designed to align with future RCP projections. Already 250 EJ/yr in 2010, 145 EJ/yr in RCP4.5 and 180 EJ/yr in RCP8.5 by the end of the 21st century. However, many questions enquiring the direct carbon cycle and climate response to bioenergy systems are debated. In particular, the climate change effects of the different greenhouse gases (GHGs) are usually aggregated into common units (e.g., radiative forcing, CO2-equivalents, or °C), for example using emission metrics like the well-known global warming potential (GWP) or Global Temperature change Potential (GTP) [2]. However, emission metrics for CO2 from forest bioenergy are not linked in general to GTP.

Bioenergy systems are largely assessed under the default climate neutrality assumption and the time lag between CO2 emissions from biomass combustion and CO2 uptake by the forest are usually accounted for. With assessment models and policy directives mainly focused on the quantification and mitigation of the risks associated with deforestation and land use changes. Whereas recent studies show that the temperature change of CO2 emissions from re-growing biomass is characterized by an initial warming followed by a smaller long term cooling [3], an analysis that disentangles the role of CO2 emissions from forest bioenergy can thus be assessed under different climate impacts of the forest.

The metrics are correlated with the site-specific turnover times and local climate variables and the characterized results are sensitive to the specific metrics used that inform about different dimensions of the climate system response to forest bioenergy. The temperature peak from bioenergy CO2 emissions is proportional to the maximum rate at which emissions occur and is nearly insensitive to the amount of cumulative emissions. While the transient climate response to cumulative emissions (TCRE) of CO2 from fossil fuels is approximately constant, the TCRE to bioenergy emissions depends on time, biomass turnover times, and emission scenarios. The linearity between temperature peak and bioenergy CO2 emission rates thus resembles the response to short-lived climate forcers. As for the latter, the timing of CO2 emissions from bioenergy matters. Under the international agreement to limit global warming to 2 °C by 2100, early emissions from bioenergy have smaller contribution to the climate change than emissions postponed later into the future.

The application of these metrics to CO2 emissions from forest bioenergy in the RCP8.5 scenario shows that emissions in 2100 use the maximum change of 145 eJ/yr in rCp4.5 and 180 eJ/yr in rCp8.5 by the end of the 21st century. Without coupling the analysis with global climate models, CO2 emissions from forest bioenergy can thus be assessed under different climate change indicators, that is, values for the temporal scales using the global maps presented in this study.


P-2216-03

A bioeconomic modelling of logged tropical forests to simulate low-carbon strategies for Central African concessions

F. Claeyss (1) ; P. Delacote (2) ; S. Gourlet-Fleury (1) ; A. Karsenty (1) ; F. Mortier (1)
(1) Centre for International Cooperation in Agricultural Research (CIRAD), Tropical Forest, Goods and Ecosystem Services (BSEF), Montpellier, France; (2) French National Institute of Agricultural Research (INRA), Laboratory of forest economics (leI), Nancy, France

Among the contributions expected from forest sectors in policies of climate mitigation, one consists in increasing forest carbon stocks by changing management practices. Change in forest management (IFM), is of major importance in the Congo Basin forests, where 20 millions of hectares are now managed for timber production. The carbon benefit generated by IFM activities is often obtained by a reduction of harvesting pressures on forest resources. In the case of Extension of Rotation Age/Cutting Cycle (ERA) projects, the reduction of emissions comes from the increase of Management Duration of rotation (MDR) and shortening of Felling Cycle Duration (FCD). However, such activities have negative consequences for the profitability of timber companies. Climate instruments such as the mechanism of reducing emissions (MR) and the climate degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries (CDM) promote a compensatory approach to cover these income losses by the valuation of avoided carbon emissions.

To determine the feasibility of such a carbon-based compensation, it is necessary to predict over the long term both the dynamics of forest carbon and the time schedule of timber incomes. The two are closely interrelated. Selective logging may occur with the high diversity of tropical forests, and thus, the carbon stocks of tropical forests. Modelling these forest—logging relationships is challenging. Selective logging implies to deploy a species level representation of timber harvesting but the high diversity of tropical forests, in pair with the scarcity of data, hinders the correct fitting of species-specific models.
We developed a bioeconomic approach coupling a mixture of inhomogeneous matrix models for forest dynamics and an object--oriented model for forest logging companies' operations. For forest dynamics, our methodology addresses the challenge of taking into account the growth of heterogeneous forest stands at different spatio-temporal scales. For the logging operations, our approach allows for the evaluation of harvest choices under technical and economic constraints, in a highly configurable manner. In the case of a Central African forest concession managed by a typical sawnwood export-oriented company, we predicted the carbon stock evolution for a wide range of ERA scenarios and for a time scale of 100 years. For several categories of carbon credit, we calculated break-even prices that would enable carbon revenues to compensate logger's loss of timber incomes.

Our simulations are based on data from the M'Baïki site, in the Central African Republic (CAR), which has been monitored for 3 years through a collaborative partnership with various French and CAR institutional and research organizations. Economic data are taken from several forest concessionaires in Central Africa. We predicted that without any logging, carbon stock would increase naturally. When logging was simulated, the carbon stock decreased during the first felling cycle and although carbon recovery could be boosted by logging, this decrease was too sharp to catch. We will thus proceed to FCD and MCD. To ensure low break even prices of carbon credits, ERA activities had to involve both FCD and MCD. In this case, we found a little dependence of the break even price on the alternative MCD and FCD, but a strong dependence of the way how carbon credits are accounted. Thus, from the perspective of the forest concessionaire, depending of the chosen type of credits, carbon revenues could compensate timber revenues for a large number of ERA projects.

We focused on IFM projects, but our approach remains applicable to other strategies of forest sustainability improvement such as Reduced Impact Logging techniques or post-logging silvicultural systems. Within the current context of REDD+ deployment, our work is a first step to spare management and adaptation of carbon-based compensation opportunities for industrial forest concessions in Central Africa, on the basis of an accurate modelling of tropical forestry.

P-2216-04
Dynamics of vegetation in Managed forest: the case of Missirah Forest in Senegal

LC. Faye (1) ; S. Bienvenu (2) ; K. Boateng (3)
(1) Kwame Nkrumah University of Science and Technology, Department of civil ingeneering, Kumasi, Ghana; (2) Institut des Sciences de l’Environnement, Faculty of science and technologyd, Dakar, Senegal; (3) Kwame Nkrumah University of Science and Technology, Natural resources, Kumasi, Ghana

In the global climate change discussion, forest management has become a major concern because of the significant role of forest in climate change as both pool and source of carbon dioxide. Climate change discussion points out the crucial role of forest sector in climate change mitigation leading to mechanisms like Clean Development Mechanism (CDM) and Reducing Emissions from Deforestation and Forest Degradation (REDD). The 11th session of the Parties in 2005 became later REDD+ integrating sustainable forest management, forest conservation, and carbon sink enhancement. In Africa, there are only few operational REDD+ programs but, the idea behind the concept is not new in African forest sector. There have been many attempts to tackle the issue of deforestation in Africa and in these attempts: agriculture, urban growth and wood extraction identified as the main drivers of deforestation. The drivers of deforestation derived from the literature are mostly the same. Nevertheless some factors are more specific to some areas. In the southern part of Senegal namely in Tambacounda and Kolda which are more specific to some areas. In the southern part of Senegal namely in Tambacounda and Kolda which are more specific to some areas. In the southern part of Senegal namely in Tambacounda and Kolda which are

P-2216-05
Population growth and deforestation in the Lake Albert region (Uganda) at the start of oil production

V. Golaz (1) ; C. Médard (2) ; F. Kisekka-Ntale (3)
(1) INED, Paris, France; (2) IRD, Paris, France; (3) DRASPACE, Kampala, Uganda

In the early colonial days, a deep political and demographic crisis hit the eastern shores of Lake Albert, Uganda (Doyle). Large areas were then set aside as forest and game reserves. Later on migratory policies and practices shifted and the area became a land frontier. Migrant settlement was encouraged by government from the 1950s onwards. New settlements were promoted by the Ugandan State in response to international refugee crises, as well as national development strategies. But the new policies have been linked to repeated encroachments on protected areas and severe deforestation. Since the 1990s, both the institutional role of national government (central state, the administration, the army, the forestry and wildlife services, etc.), and political patronage have consolidated Museveni’s regime in somewhat contradictory ways. These are often described as positive and sustainable, especially locally at the start of a new oil frontier. Through a detailed mapping of population densities and growth and an analysis of qualitative interviews conducted in 2012-2013, in a collaborative research framework (M-PRAM, CPAS – IRD, Makerere University), we highlighted increased vulnerability and inequalities as well as potential conflicts. Although climate variability is a factor of change locally, the short term issue shaping resource degradation is governance.
We develop a multi-dimensional framework to explore the extent to which carbon forestry initiatives concern, and use three Belizean projects as case material. We demonstrate that the rhetoric of linking adaptation and mitigation is not easy to hold, because the management of forest carbon markets does not incorporate adaptation concerns. Projects’ contribution to adaptation relate to unintended forestry and biodiversity aspects while, critically, their mitigation potential is debatable and their livelihood outcomes are limited in scope and relevance. We conclude that integration of adaptation and mitigation in Belize’s carbon offset projects remains a laudable but elusive goal.

**P-2216-08**

Climatic impacts on managed forests: predicting the future from the past

S. Martel (1); D. Picart (1); C. Moisy (1); S. Lafont (1); D. Loutau (1); A. Bosc (1); O. Picard (2); V. Badeau (3); N. Breda (3); J. Boiffin (3)

(1) INRA, Ispa, Villeneuve d’Ornon, France; (2) CNPF, Idf, Paris, France; (3) INRA, Eef écologie et ecophysiologie forestières, Champenoux, France

Foods are one of the most vulnerable ecosystems under the changing climate. Growth and development of a forest depend on the climatic and weather conditions. Similarly, forest resources are also important for household income and meeting the needs for fuel for cooking.

In response to very high deforestation in the mountainous regions of KP, the government initiated the process of community based forest management in the province with the objective to reduce forest depletion with the help of community participation. This paper attempts to analyze the impact of community forest management on climate change mitigation efforts as well as on the livelihoods of local communities. The paper also attempts to answer the question that how the efforts of the state and communities regarding climate change mitigation are augmented (or otherwise) with the change of system. More specifically, the paper addresses the following questions:

1. What are the patterns of climate change in the study area?
2. What is the impact of participatory forest management on livelihoods of local communities?
3. How local livelihoods and farming practices changing with the time and what are the coping strategies of farmers in the event of climate extremes?
4. What are the perceptions of local people regarding sustainable forest management and climate change mitigation in the context of participatory forest management?
5. What is the link of participatory forest management with future climate change mitigation and adaptation?

Key–informant interviews and focus group discussion was used to collect information from farmers of selected villages. Life histories of some respondents were also recorded find–out how changes in forest management paradigm are linked with livelihoods and farming practices and climate change.

**P-2216-07**

Linking adaptation and mitigation in carbon sequestration projects: evidence from Belize

R. Kongsager (1); E. Corbera (2)

(1) UNEP DTU Partnership, Copenhagen, Denmark; (2) Universitat Autònoma de Barcelona, Barcelona, Spain

We present in this communication how two modeling approaches for predicting the future of managed forest at country scale might optimize past observations to strengthen their likelihood and reduce uncertainty of their projections. In situ observation networks such as flux tower networks (FLUXNET, ICOS), ICP forest network and National Forest Inventories are the main data sources used.

The climate niche modeling predicts the potential distribution of forest species in the geographic domain using past observations of climate and water balance and presence/absence of tree species. Results show an expected poleward shift of forest biomes or species due to global warming and water balance changes that may reach several 10s to 100s of km during the 21st century. Similarly, a process based model can be calibrated and evaluated using past observations to predict forest functioning as forced by climate scenarios. The energy balance and the carbon and water cycles in the soil–plant–atmosphere system are modeled at an hourly scale and integrated over an annual time frame. As a disturbance in the temperate forests, management is integrated through practices such as ploughing, thinning or clearcutting.

Long time series of flux measurements in monospecific forest stands are used to calibrate the model while adjusting parameters. In a second step, models have been run in various ecological conditions and we have compared the outputs to long time series of observed data from forest inventories or monitoring networks to model predictions. Last, we use climate projections derived from RCP scenarios until 2100 at 8x8 km grid to force the models.

This work is conducted across the French metropolitan area for 3 of the main European forest species: Maritime Pine, common Beech and Douglas–fir. Our results provide an evaluation of the ecosystem services (carbon sequestration, wood supply, water regulation) taking into account climate change. Based on these results we will
discuss about the way to manage/optimize these French forests in the future. To enhance cooperation between researchers and stakeholders, a panel of managers and decision makers has been involved to implement various forest management scenarios in the model.

**P-2216-09**

**Managing of risks in Agriculture: Benefits of Conservation of forest resources in Anambra State, Nigeria**

O. Ogbonna (1)

(1) University of Nigeria, Agricultural Extension, Nsukka, Enugu State, Nigeria, Federal Republic of Nigeria

Forest management offers a promising alternative to depletion of forest resources. Continuous degradation of the forest reserve base has major effects on other segments of the economy. This includes reduction of forest cover leading to erosion and soil degradation. This study assessed the losses of farmers in conservation of forest resources; benefits of conservation of forest resources in the area and reasons for loss of forest resources in the area. Multi-stage sampling procedure was used to select 120 respondents for the study. Data were analysed with the use of descriptive statistics. Results show that reasons for loss of forest resources in the area included: excessive farming (M=2.8) and rapid urbanisation (M=2.0). Roles of farmers in conserving forest resources were: avoidance of illegal hunting and poaching (M=3.0), practicing continuous forestation (M=3.2) and prevention of bush burning in forest areas (M=3.4). Benefits of conservation of forest resources in the area included: protection of forest cover (M=2.3), prevention of climate change (M=2.4) and retaining economic benefits from the forest (25). Hence it was recommended that there should be proper planning for farming and urbanisation for conservation of forest resources in the area.

**P-2216-10**

**Multiple trade-offs in forest management facing climate change**

JL. Peyron (1)

(1) ECOFOR, PARIS, France

Forests are able to mitigate climate change through carbon sequestration, storage, and substitution. But these different options are generally conflicting. How should they be combined? This question is a first major challenge for forest management and policy. In parallel, forests are impacted by climate change through trends (beneficial or detrimental) and extreme events. They may adapt and deserve to be adapted to these gradual or brutal phenomena. Integration of trends and extreme events is a second major challenge for forestry. Adaptation and mitigation have to be distinguished because they are very different responses to climate change. In the same time, they are interrelated since mitigation supports carbon regulation as an ecosystem service influenced by forest adaptation. Trade-offs between forest management and trade-offs also exist between climate change mitigation and sustainability at large. This presentation will overcome these four issues from models running at national and stand levels.

At national scale, the carbon balance of French forests will be projected over the 21st century according to scenarios combining various harvest options with different climate change intensities. At stand level, a micro economic model will combine trends and extreme events, mitigation options and climate change impacts in order to find the best rotation age. The results of these models at two different scales will then be discussed in the frame of sustainable forest management.

**P-2216-11**

**National Strategy for Adaption to Climate Change in Hemiboreal Estonia: Forestry**

H. Tullus (1) ; M. Suškevičs (2) ; A. Tullus (3) ; R. Lutter (1)

(1) Estonian University of Life Sciences, Institute of forestry and rural engineering, Tartu, Estonia; (2) Estonian University of Life Sciences, Institute of agricultural and environmental sciences, Tartu, Estonia; (3) University of Tartu Institute of ecology and earth sciences, Tartu, Estonia

Climate change can considerably affect ecosystems and different bioeconomy-sectors. In addition to climate change mitigation it is important to know relevant adaptation options. Many EU states already have national adaptation strategies and action plans. Estonia will have a comprehensive national adaptation strategy and action plan in 2016.

The special project for adaptation policies in Estonia is created in 2015 „Climate change adaptation strategy and measures for thematic fields of natural environment and bioeconomy: BioClim.“ (http://pk.emu.ee/en/structure/landscapemanagement/projects/bioclim/project/).

There is a chapter about forestry in the National Strategy Plan for Adaptation to Climate Change in Estonia. Also in the Estonian Forestry Development Plan until 2020 the climate change impacts and mitigation is concerned (http://www.envir.ee/sites/default/files/efinder/article_files/mak2020vastuvoetud.pdf).

Basic studies about climate change impact on functioning of forest ecosystems are conducted in Estonia in the Free Air Humidity Manipulation Experiment (FAHM, https://sisu.ut.ee/fahm/). An experimental facility was created in collaboration with researchers of plant ecophysiology, applied ecology and forestry from University of Tartu and Estonian University of Life Sciences.

FAHM is a unique open-air experiment where acclimation and functioning of trees and forest stands under elevated atmospheric humidity conditions is studied. Results of FAHM and their theoretical interpretation is a basis for prognosis of climate change impact on Estonian forest ecosystems and life activities of trees.

Climate change will likely cause significant long-term changes in the entire Estonian forest sector. The main impacts of climate change for hemiboreal forests and forest management in Estonia are:

- The proportions of tree species and balance between coniferous and deciduous forests will change.
- Forest industry must consider with changes in local wood assortment.
- The quality of timber may reduce.
- Extreme weather events may cause considerable and unavoidable damage.
- The risk of wind damages will increase.
- The reduced period of frozen ground makes timber harvesting more difficult.
- Increasing precipitation means more investment into forest roads and ditches.
- One of the most important possible hazards associated with climate change concerns forest pests and diseases, especially outbreaks of invasive diseases and mass production of insect pests.

Novel adaptation methods must be elaborated in forest plant production, tree selection and breeding, tending of forests, forest protection, felling systems and forest pathology.

**P-2216-12**

**Potential Risk of Wildfire under Climate Change in Croatia**

M. Vucetic (1)

(1) METEOROLOGICAL AND HYDROLOGICAL SERVICE, AGROMETEOROLOGICAL DEPARTMENT, ZGREB, Croatia

The weather conditions such as a long–lasting dry spell and insolation duration, high air temperature and strong wind essentially increase the potential risk for starting and spreading of wildfires. All these relevant factors are observed on the Croatian Adriatic coast and islands and lead to the conclusion that the Adriatic area is prone to wildfires during summer season. The main goal is to research the regional impact of climate change on the potential greater risk of wildfires in Croatia from May to
Abstract

September. Monthly and seasonal severity rating (MSR) and SSR are used as indices for the potential risk assessment of forest fires which are one of the products of the Canadian Forest Fire Weather Index System. According to the map presentation of mean long-term seasonal severity ratings, for the standard climatic period 1961-1990, the most endangered area is the mid-Adriatic coast with the adjacent islands. Using the secular weather series of Crikvenica and Hvar in the period (1901–2014), which represent the northern and southern distribution of the islands respectively, the secular variations of MSR has been estimated. In order to establish the eventual increase in potential wildfire risk on the Croatian mountainous hinterland and islands, the Gostomlaki, Zagreb–Gric and Osijek has also been used for the MSR assessment. A significant monthly increase (significant level is 0.05) in the MSR was observed for Crikvenica for all months of the period considered and for Hvar in June and July. This increase is particularly important for June, as it indicates the possibility of the earlier onset of the forest fire season on the Adriatic area. The analysis also showed spreading of high potential risk of wildfire from the mid-Adriatic to the northern, especially in July and August in the last 114 years. However, positive trend of potential risk of wildfire noticed in the eastern part of Croatia in the last 64 years. Tendency of increase the potential risk of wildfires in Croatia is in accordance with the projections of climate change. Thus, forest fire regime in our country fits well into the larger picture of increasing areas of high threat of wildfires in the Mediterranean and Eastern Europe in the summer months in future.

2217 - Global scenarios of land-use change and land-based mitigation, and their importance in the climate system

ORAL PRESENTATIONS

K-2217-01

Robust knowledge on land use change and climate at the science-policy interface

J. House (1); A. Arneth (2); R. Berman (3); A. Cescatti (4); E. Massey (5); N. De Noblet-Ducoudré (6); L. Perugini (7); A. Popp (8); MD. Rounsevell (9); A. Savaresi (10); D. Van Vuuren (11)

(1) University of Bristol, School of geographical sciences, Bristol, United Kingdom; (2) KIT, Atmospheric Environmental Research, Garmisch–Partenkirchen, Germany; (3) University of Edinburgh, School of Geosciences, Edinburgh, United Kingdom; (4) Institute for Environment and Sustainability, Climate Risk Management, Ispra, Italy; (5) Institute for Environmental Studies, VU university amsterdam, Amsterdam, Netherlands; (6) Laboratoire des Sciences du Climat et de l’environnement, CEA-CNRS-UVSQ, Gif-sur-Yvette cédex, France; (7) Euro-Mediterranean Center on Climate Change, Division on Climate Change Impacts on Agriculture, Forests and Ecosystem Services (IAFES), IAPES, Viterbo, Italy; (8) Potsdam Institute for Climate Impact Research, Potsdam, Germany; (9) University of Edinburgh, School of geographical sciences, Edinburgh, United Kingdom; (10) University of Edinburgh, School of Law, Edinburgh, United Kingdom; (11) PBL Netherlands Environment Agency, PBL Climate, air pollution and energy, Bilthoven, Netherlands

Land Use, Land Use Change and Forestry (LULUCF) contributed 24% of total greenhouse gas emissions and 11% of CO2 emissions in the 2000-2009 period (IPCC, 2014). Land-based mitigation strategies are essential to achieving the 2°C target, with most current mitigation scenarios invoking substantial negative emissions from afforestation and from bioenergy with carbon capture and storage (BECCS), in addition to Reduced Emissions from Deforestation and Degradation (REDD+). Improved agricultural management: Reporting and accounting of some LULUCF activity is already embedded in international climate policy. Negotiations leading up to adoption of new international climate agreements in 2015 (Paris climate agreement) are expected to include further LULUCF activities, particularly REDD+. This reliance on land-based mitigation options necessitates that LULUCF policy is in-line with the latest evidence across the natural and social sciences, and that scientific research reflects policy needs. This presentation will review the importance of LULUCF mitigation options in current and planned policy, using mismatches with scientific knowledge, often due to different considerations of spatial and temporal scales. We will also explore time lags between the emerging scientific insights, policy targets and commitments and changes in activity leading to desired changes in physical and ecological systems.

For example, scientific research has long emphasised the importance of REDD+ as a low cost, multiple-benefit near-term mitigation option, although international policy is only just catching up. New analyses of the biophysical climate impacts of land use change from both observations and Earth System Modelling (ESM) further confirm the importance of tropical forests as providing a cooling effect through changes in the surface energy budget and in evapotranspiration rates. The biophysical climate effects of afforestation in temperate and boreal areas can however either amplify the biogeochemical cooling effects (e.g. through enhanced evapotranspiration in summer) or dampen them (e.g. through reduced surface albedo in winter). At the global scale, net biophysical effects are small and bio-physical effects (e.g. through enhanced evapotranspiration and sinks of CO2) dominate the climate impacts of LULUCF. The regional nature of the effects and the still large uncertainty in the science imply that the evidence base is not yet sufficient to implicate changes in international climate policy, particularly related to afforestation/ reforestation activities, although effects are likely to be important to consider in regional or national adaptation policy. Biophysical effects should be considered in the current development of land-based mitigation scenarios and modelling capacity for the next generation of integrated climate-nature-society-policy projections so the implications can be assessed.

Bioenergy has been one sector where controversies in scientific understanding, socio-economic modelling and policy implementation have been particularly apparent and there is a need for the stronger use of evidence and more joined up approach. Recent studies suggest that in the longer term bioenergy may provide larger offsetting potential than afforestation where contribution is small once forests reach maturity. However, to fully reach the potential it will be important to ensure technological improvements, assess full life-cycle costs, and the implementation of sustainability criteria. Given the potential lags in the scientific, technological and uptake steps, more resources needs to be put in place now or soon if BECCS is to be expected to contribute significantly to global mitigation by 2050.

K-2217-02

‘Land-Use and Climate, IDentification of robust impacts’ (LUCID): What have we learned from this project (2008-2013)?

Suggestions / attempts to move forward

N. De Noblet-Ducoudré (1); A. Pitman (2); V. Brovkin (3)

(1) Laboratoire des Sciences du Climat et de l’environnement, CEA-CNRS-UVSQ, Gif-sur-Yvette cédex, France; (2) ARC Centre of Excellence for Climate Extremes, university of new south wales, Sydney, Australia; (3) Max Planck Institute for Meteorology, Hamburg, Germany

The objectives of the LUCID international project are to qualify and quantify robust biogeophysical and bio-geochemical impacts of land-use induced land-cover changes on climate (LULCC), from pre-industrial times to nowadays, and from this to constrain the potential of the bio-geo-physical climate impacts of land use change. By ‘robust’ we mean that is above the noise generated by model variability and consistent across multiple climate models.

Two steps were undertaken for the 1st phase: one focused on historical climate (from ~1870 till years 2000), and another looking into the future (outlook and papers may be found on our web site: http://www.lucidproject.org.au/index.html).

Seven modelling groups contributed to the historical part. They all conducted two series of two experiments using
observed interannually and seasonally varying SST and sea level, for both present-day and pre-industrial conditions, forced with two sets of land cover distributions reflecting the state of the canopy respectively in ~1870, and ~1992.

We have demonstrated that climate change in large regions of the northern hemisphere may be as much influenced by LULCC than by changes in global quantities (e.g. SST, SLP) with either amplifying or dampening effects. Moreover externalities (e.g. temperature) simulated in climate models are quite sensitive to LULCC (Pitman et al. 2012). Detection/attrition of local to regional changes in climate-meteorology may therefore be strongly biased if one does not account for changes in local to regional land–uses. Similarly we emphasized that downscaling of global climate simulations must include land–use changes.

We have also shown that the response of individual models to deforestation varies not only in magnitude but also in sign and there is a need to properly evaluate the sensitivity of our LSMs (and then our coupled LSM-GCMs) to land-use changes and to land uses using a wide range of observational data examples was done in Boisier et al. (2013 and 2014).

During the LUCiD exercise, we have discovered that being forced to a set of crops and pastures maps to land–cover maps was not only a difficult task as it involves choices, but was also a need to increase the dispersion between the models’ results. There is a need to better interact upstream IAMs who provide climate modelers with such maps.

The LUCID community also contributed to the fifth Coupled Model Intercomparison Project (CMIP5) and analyzed scenarios of future climate change. Six CMIP5 modeling groups performed additional LUCiD–CMIP5 simulations forced with land–use changes from 2006 to 2100. Those analyses revealed that the effects of land–use changes on mean annual temperature in RCP8.5 and 2.6 scenarios are significant for regions with land–use changes exceeding 10%. Changes in land surface albedo, available energy, and latent heat fluxes are small but significant for most ESMs in regions affected by land–use change (Brovkin et al., 2013). These climatic effects are relatively small, as land–use changes in the RCP2.6 and RCP8.5 scenarios are small in magnitude and mainly limited to tropical and subtropical regions. Crops tend to warm climate to a greater extent in most models than pastures. The climate impact of LULCC forcing and the climate impact is found in some models where the presence of pastures tends to induce a local biogeophysical cooling which offsets a biogeochemical warming. Conversion to pastures thus may have a climate change mitigation potential but more detailed and idealized experiments are required.

K-2217-03

Shared Socio-economic Pathways – a framework for assessing potential land use futures –
A. Popp (1); K. Calvin (2); P. Havlk (3); F. Shinichiro (4); E. Schrötter (5)
(1) Potsdam Institute for Climate Impact Research, Potsdam, Germany; (2) JGCRI, Joint Global Change Research Institute, College Park, United States of America; (3) IIASA, Laxenburg, Austria; (4) National Institute for Environmental Studies, Tsukuba, Japan; (5) PBL Netherlands Environmental Assessment Agency, The Hague, Netherlands

Today, land-use and land–use changes are responsible for CO2 emissions from a quarter of global greenhouse gas emissions, largely from tropical deforestation, methane emissions from livestock and rice cultivation, and nitrous oxide emissions from livestock and fertilized soils. But, the land system is also seen to contribute much to climate change mitigation in the future by providing biomass for bioenergy, improved agricultural management and conserving or even enhancing carbon stocks of ecosystems. The degree of both, future emissions but also mitigation potential of the land depend strongly on uncertain trends in population growth, dietary changes, trade, possible demand for non-food products such as bioenergy, future developments in agricultural yields, and policies. Over time, these uncertainties may result in many different land-use patterns and associated emissions.

Scenario analysis has been established as a tool to explore and evaluate such extensive uncertainties associated with possible future developments. Recently, new scenarios have been developed that are organized around two important dimensions. The five radiative forcing levels consist of four representative concentration pathways (RCPs) which determine the amount of climate change. The possible future socio–economic conditions that could correspond to individual forcing levels are termed ”shared socio–economic pathways” (SSPs). The SSPs provide 5 different stories of future socio–economic development, including possible trends in agriculture and land use.

Future emissions and their feedbacks to the climate system are a function of complex interaction between all kinds of socio–economic factors, including population dynamics, economic development, technological change, trade, cultural and institutional changes and interaction with other sectors such as bioenergy demand for energy supply and transport. In each of the SSPs, climate policies can be introduced to reduce emissions or to enhance carbon uptake to reach radiative forcing level targets consistent with the RCP scenarios.

In this presentation, we will first present relevant aspects of the SSP framework for the land system. Then, based on a study that applied the scenario matrix approach combining climate forcing and socioeconomic dimensions for the assessment of land use changes in dedicated land use modules, we will focus on possible future pathways for these drivers and their consequences on the land system, associated emissions and mitigation potential.

O-2217-01

Risk-aversion Behavior in Smallholder Farmers and Climate Change. Evidence from Empirical Work in Zambia
A. De Pinto (1); V. Smith, (2); R. Robertson, (1); A. Haruna, (1)
(1) International Food Policy Research Institute, Washington, DC, United States of America; (2) Montana State University, Economics, Bozeman, United States of America

When the economic effects of climate change are considered, decision-making under uncertainty and risk are necessarily of the forefront and need to be analyzed. The consensus is that, in the developing world, smallholder farmers are among the most vulnerable to the effects of climate change and, especially, to the adverse consequences that derive from more volatile and extreme weather events with which climate change is associated. Furthermore, there is overwhelming empirical evidence that risk considerations affect farmers’ land allocation and other input usage decisions as well as their technology adoption choices. However, apart from the body of research on index insurance, an extensive review of the empirical literature deals with climate change and risk aversion, and the role and the risk–aversion are notably not taken into account in models that estimate the impacts of climate change on agricultural production, market prices and food security for the poor. In particular, those models do not consider the effects of climate change related increases in yield and price volatility on farm household choices with respect to production strategies that provide adaptation or mitigation services. In fact, farmers and farm households respond to changes in the riskiness of their decision making environments as well as to changes in expected average yields, crop prices and input prices. How they respond depends on several factors and are widely viewed as important in many contexts, not least when exogenous shocks such as climate change alter the fundamental nature of the production environment in which farmers operate. When the literature reviews the risk in the farm household’s production decisions by using a widely available household survey of farmers in Zambia to build a theoretically based empirical model of land–use choices. The model accounts for attitudes to risk and analyzing the effects of climate change on farm–level land allocation to crop production. The empirical specification
is based on a relatively simple discrete–choice model (nMID) and argued by risk variables with a mean–variance utility function. After the system is shocked with changes in temperatures, precipitation, and distribution of crop yields consistent with regional effects of climate change decisions. These resulting production trends are aggregated and evaluated at the country level. Shifts in the geographical pattern of crop production appear evident using this analysis with crops that are largely replacing local and特种 production. More importantly, results indicate that in the case of Zambia the aggregate effects of risk–mitigating decisions exacerbate trends driven by the biophysical changes caused by climate change. These results represent a form of adaptation of small households to the changing climate. The effects of this form of adaptation, developed in the constraints of smallholder production, appear to be important for understanding agricultural sector with important implications for market prices and food security for both the rural and urban poor. Three important conclusions follow from our analysis. First, the effects of farmers’ risk attitudes should not be ignored and should be accounted for in empirical models of the impacts of climate change. Second, concentrating on farm–level responses to climate change is not sufficient. It is essential to develop methods of aggregating individual responses to climate–change–related shifts in risk so that they can be reflected in models of regional and national crop and livestock markets. This is required to understand how changes in risk will impact farmers’ land–use and production decisions will enable policy makers to more effectively assess the benefits and costs of a wide range of policies intended to mitigate climate change’s adverse effects.

O-2217-02

Quantifying the impact of LULCC on biogeochemical cycles into the future under alternative mitigation options and policy scenarios. What are the carbon and water costs of different mitigation options?

M. Groenendijk (1); P. Anthoni (2); A. Arneth (2); A. Bondeau (3); P. Ciais (4); J.C. Doelman (5); P. Friedlingstein (1); E. Hugelius (1); M. Lawrence (6); M. Liedl (2); M. Liu (7); E. Luyssaert (1); G. Guenther (6); N. De Noblet-Ducoudré (4); A. Popp (6); T.A. Pugh (2); S. Sitch (1); E. Stehfest (5); D. Van Vuuren (5); C. Yue (4)

(1) University of Exeter, Exeter, United Kingdom; (2) KIT, Atmospheric environmental research, Garmisch–Partenkirchen, Germany; (3) Institute for Biodiversity and Ecosystem Research, Montpellier, France; (4) Laboratoire des Sciences du Climat et de l’Environnement, Gif-sur-Yvette, France; (5) PBL Netherlands Environmental Assessment Agency, Bilthoven, Netherlands; (6) Potsdam Institute for Climate Impact Research, Potsdam, Germany

Future impacts of land–use and land–cover changes (LULCC) on the biochemical cycles and biophysics are highly uncertain. Firstly, there are large uncertainties in possible future social, economic, and policy options (e.g., food demand, trade liberalisation, technological development). Second, there are uncertainties in how cropland, pasture, and natural vegetation respond to changes in climate, which is a major component of the current understanding of the effects of climate change on ecosystem services and food and income security. Third, our results suggest that not accounting for farmers’ risk attitudes may lead to significant changes in policy. It is also the case that the climate impacts of land–use and production decisions will enable policymakers to more effectively understand the benefits and costs of a wide range of policies intended to mitigate climate change’s adverse effects. O-2217-03

Understanding the role of land management for carbon and climate mitigation under RCP 4.5 and RCP 8.5 using the Community Earth System Model

P. Lawrence (1); B. O’Neill (2)

(1) National Center for Atmospheric Research, Climate and Global Dynamics Division, Boulder, United States of America; (2) National Center for Atmospheric Research (NCAR), Boulder, CO, United States of America

As part of the Coupled Model Intercomparison Project phase 5 (CMIP5), land cover change and wood harvest were described as part of the experiment for the future and were also included in the study for the historical time series as well as RCP 4.5 and RCP 8.5. Land cover change fluxes to the atmosphere found in the CMIP5 simulations did not account for the lost uptake of carbon that would have been possible in the absence of land cover change and wood harvest. Once these losses are taken into account, the historical losses of terrestrial carbon increased from 61.2 PgC to 125.6 PgC. The RCP 4.5 uptake of 62.8 PgC changed to a loss of 5.8 PgC, and the RCP 8.5 loss of 49.0 PgC increased to 168.8 PgC. In order to assess the potential of land management to mitigate carbon and climate change, two consequences of the most under arid and sandy soil conditions: results from a meta-analysis

K. Abdalla (1); V. Chaplot (2); P. Chivengue (1)

(1) University of KwaZulu–Natal, Centre for Water Resources Research, School of Agricultural, Earth & Environmental Sciences, Pietermaritzburg, KwaZulu-Natal province, South Africa; (2) Institute for Research for Development (IRD), Laboratory of oceanography and climate (Iocean), pierre and marie curie university, Paris, France

The management of agroecosystems plays a crucial role in the global C cycle with soil tillage leading to known organic carbon redistributions within soils and changes in soil CO2 emissions. Yet, the SOC-CO2 emissions in the IPCC report. More importantly, results indicate that in the case of Zambia the aggregate effects of risk–mitigating decisions exacerbate trends driven by the biophysical changes caused by climate change. These results represent a form of adaptation of small households to the changing climate. The effects of this form of adaptation, developed in the constraints of smallholder production, appear to be important for understanding agricultural sector with important implications for market prices and food security for both the rural and urban poor.
Potential impacts of forestation on the future climate change in Southern Africa

A. Babatunde (1); M. Naik (1)
(1) University of Cape Town, Environmental And Geographical Science, Cape Town, Western, South Africa

Many studies have projected the future climate change over Southern Africa, but without including the influence of on-going forestation activities in the region. The present study investigates how the forestation activities may alter the projected climate change. For the study, two regional climate models (RegCM4 and WRF) were applied to simulate the present-day (1970–2005) climate, and the future (2030–2065; IPCC RCP 4.5) climate, with and without forestation. The simulations account for the potential impacts of natural bush encroachment and the commercial forestation over the eastern part of South Africa. The results agree with previous studies in that the elevated greenhouse emissions would induce warming over Southern Africa in the future, but the results further indicate that forestation would enhance the warming over the forested area and induces cooling elsewhere. The additional warming over the forested area is due to the albedo-effect of the forestation, while the cooling is due to the dynamic feedback of the local warming over the forested area. For similar reasons, the forestation would induce both wet and dry conditions over the sub-continent in future. As a result of its combined influences on rainfall and temperature, the forestation would enhance drought frequency over some areas, but reduces it over other areas in Southern Africa. This study suggests that using forestation to mitigate the impacts of global warming may produce unintended climate impacts over some areas in Southern Africa. Hence, the biophysical effects of forestation in Southern Africa should be weighed against the biogeochemical benefits.

Low-Density Development and the Increasing Greenhouse Emissions in Malaysian Special Economic Zones

A. Barau (1)
(1) Universiti Teknologi Malaysia, Urban and Regional Planning, Johor Bahru, Johor, Malaysia

Low-density development is one of the major problems associated with rapid urbanization in the global south. Special economic zones (SEZs) constitute new layers of capital-driven urbanization and industrialization in many Asian emerging economies. In many Asian countries, SEZs cause rapid fragmentation of landscapes within and around urban areas. This paper focuses on Iskandar Malaysia, one of the most successful emerging SEZs in Southeast Asia. This economic region has attracted more than US$25 billion so far from the expected US$100 billion investments in housing, education, tourism and infrastructure to be realized by 2025. Recent studies have projected that by 2025, if the business as usual model continues, the region’s greenhouse emissions and energy consumption will increase more than 70% and 80% respectively. The paper aims to link and discuss how fragmentation of agricultural landscapes, mangroves, coastal vegetation and other green areas give rise to increasing emissions through new urban development projects. The current study relied heavily on fieldwork, landscape metrics for calculation of landscape change using GIS and FRAGSTATS. The study findings used established examples within the region and beyond, to estimate increases in emissions and carbon storage capacities from fragmented agricultural landscapes, mangroves, new low-density development activities, and expanded roads. The findings clearly showed that land-use change and the principal source of carbon emissions that climate scientist underestimate in the Asian emerging economies. The study highlights the critical threats of low-density development in increasing carbon emission.

Understanding complex networks, trade-offs and synergies within the science-policy domain for land-based climate mitigation

R. Berman (1); MD. Rounsevell (2)
(1) University of Edinburgh, School of Geosciences, Edinburgh, United Kingdom; (2) University of Edinburgh, School of geographical sciences, Edinburgh, United Kingdom

The agriculture, forestry and other land use sector (AFLU) is a major contributor to greenhouse gas (GHG) emissions. Mitigation within this sector, as well as the interplay between mitigation and adaptation, are crucial therefore in efforts to address climate change. The highly complex institutional structures of global climate policy and the ‘wickedness’ of the climate change problem lead to trade-offs and synergies within and across land-based mitigation and adaptation policy. Hence there is a need to investigate and examine the mechanisms surrounding the policy environment. Many scientific studies on adaptation and mitigation under change, are crucial for understanding on both direct and indirect trade-offs and synergies within climate adaptation and (land-based) mitigation policy and may be expected, other gaps within the policy arena are likely to exist.

We map these complex policy and scientific arenas through a content analysis of the global scientific knowledge of climate change (from peer-reviewed literature) and of global policy approaches (using International Environmental Agreements). Overlaps and synergies between relevant topics and sectors that exist across different policy and science themes are identified and analysed through a network analysis approach. This approach enables not only the identification of key topics within the science-policy interface, but also the degree of overlap between these topics.

This presentation summarises the findings of a series of research questions which have sought to unpack the complex networks between science and policy, but also within global climate policy itself. These include:

- What are the key trade-offs and synergies within global land-based climate policy?
- How has the science-policy relationship changed historically?
- Is there a current mismatch between the global scientific understanding of land-based mitigation and adaptation and global climate policy?

By mapping the current policy network, we show that opportunities for policies to have triple-wins, supporting adaptation, mitigation and sector specific development. Furthermore, we identify gaps within the political environment to which future policy decisions should seek to contribute in order to deliver and enhance land-based mitigation. Comparing the political network to the mapped network of current scientific understanding, we identify key trade-offs that policy needs to account for, and explore how this has varied over time.

Land Use Change as Barrier and Enabler for Integrated Climate Change Responses

I. Brown (1); D. Feliciano (2)
(1) James Hutton Institute, Aberdeen, United Kingdom; (2) Institute of Biological and Environmental Sciences, School of Biological Sciences, Aberdeen, United Kingdom

Land has a finite supply but is subject to an increasing range and intensity of demands that usually involve complex interactions between climate and socioeconomic factors. We have used detailed land use survey data and interviews to investigate these interactions in Scotland (UK) and how they may shape future landscapes using scenario analysis that combines these data with global drivers. The analysis shows the importance of considering ‘path dependency’ in the evaluation of both adaptation and mitigation land use options. It also highlights that current separation of land mitigation strategies can result in them ‘competing’ for the same area of land.

Biophysical factors that influence land supply, including climate and soils, have been analysed using land capability/suitability concepts to investigate the changing options
available for land managers. Socioeconomic factors have been summarised in terms of the 5 Ps (Policy, Preferences, Prices, Power, Path Dependence) to provide a framework for understanding their relative influence. These influences vary between different localities and regions, and their relative importance may differ. High quality land in the lowlands is currently prioritised for food production and much of the land in the uplands has very limited options therefore is effectively prioritised for natural carbon sequestration and biodiversity. The scale and dynamics of future land use change (LUC) are very uncertain. The recently proposed concept of Shared Socio-economic Pathways (SSP) allows us to systematically analyze some of the uncertainties. Integrated assessment models, like IMAGE, can explore the linkages within these scenarios between socio-economic drivers, technology projections, developments in the energy system, policy assumptions

Global assessment of the biophysical climate impacts of deforestation

A. Cescatti (1); R. Alkama (1)
(1) Institute for Environment and Sustainability, Climate Risk Management, Ispra, Italy

Deforestation impacts climate in two major ways: affecting the atmospheric CO2 concentration and modulating the land–atmosphere fluxes of energy and water vapor. Given the complex role of forests in biophysical processes, such as the exchange of energy and water vapor, it is still uncertain in sign and magnitude. It has been shown that deforestation causes local changes in air temperature that varies in sign and magnitude according to the climate zone. In addition, forest losses affect the local climate also by altering the diurnal and annual temperature variations. These experimental evidences provide a global and robust quantification of the biophysical signal of deforestation and a novel assessment of the mitigation potentials of forests on the diurnal and seasonal temperature variations. Overall, the observation-driven, global quantification of the biophysical effects of deforestation provided in this study may support the inclusion of land biophysics in climate negotiations and the definition of novel protocols for the measurement, reporting, and verification of these relevant effects.

Quantifying the relative importance of land cover change from climate and land-use in the representative concentration pathways

T. Davies-Barnard (1); P. Valdes (2); A. Wiltshire (3); C. Jones (3); J. Singarayer (4)
(1) University of Exeter, Exeter, United Kingdom; (2) University of Bristol, Bristol, United Kingdom; (3) Met Office Hadley Centre, Exeter, United Kingdom; (4) University of Reading, Reading, United Kingdom

Climate change is projected to cause substantial alterations in vegetation distribution, but these have been given little attention in comparison to land-use in the Representative Concentration Pathway (RCP) scenarios. Here we assess the climate-induced land cover changes (CILCC) in the RCPs, and compare them to land-use land cover change (LULCC) in the SSP scenarios. For this, we ran an ensemble of simulations with and without LULCC in earth system model HadGEM2-ES for RCP2.6, RCP4.5 and RCP8.5. We find that climate change causes an expansion poleward of vegetation that affects more land area than LULCC in all of the RCPs considered here. The terrestrial carbon changes from CILCC are also larger than for LULCC. When considering only forest, the LULCC is larger, but the CILCC is highly variable with the overall radiative forcing of the scenario. The CILCC forest increase compensates 90% of the global anthropogenic deforestation by 2100 in RCP8.5, but just 3% in RCP2.6. Overall, larger land cover changes tend to originate in LULCC and are in lower or lower radiative forcing scenarios, and from CILCC in the longer term and higher radiative forcing scenarios. The extent to which CILCC could compensate for LULCC raises difficult questions regarding the need for carbon dioxide offsetting, especially at different timescales. This research shows the importance of considering the relative size of CILCC to LULCC, especially with regard to the ecological effects of the different RCPs.

Uncertainties of future land use change and the potentials of land-based mitigation - an analysis with the SSP scenarios and the IMAGE 3.0 integrated assessment modelling framework

J. C. Doelman (1); E. Stehfest (2); D. Van Vuuren (3)
(1) PBL Netherlands Environmental Assessment Agency, Climate, Air and Energy, Bilthoven, Netherlands; (2) PBL Netherlands Environmental Assessment Agency, The Hague, Netherlands; (3) University of Twente, Enschede, Netherlands

Historically, the continuous increase in anthropogenic land use has been an important driver of CO2 emissions and biodiversity loss. The scale and dynamics of future land use change (LUC) are very uncertain. The recently proposed concept of Shared Socio-economic Pathways (SSP) provides a framework to systematically analyze some of the uncertainties. Integrated assessment models, like IMAGE, can explore the linkages within these scenarios between socio-economic drivers, technology projections, developments in the energy system, policy assumptions
and implications for future land-use. It can also look at future land use projections which are dynamically coupled to changes in the global climate and carbon cycle. This provides the possibility to determine the potential of land-based mitigation options, and directly assess the change in carbon emissions under different scenarios. In this contribution, we present a recent IMAGE analysis using the SSPs to explore the uncertainty in future land use in relation to mitigation action.

The analysis shows anthropogenic land use (crop and pasture land) could increase by 4 million km² (SSP3, driven mostly by population growth and dietary changes), but no increase is observed by SSP1 resulting from yield improvements and intensification). Cumulative CO₂ emissions from LUC by 2100 range from an increase of 280 Gt CO₂ (SSP3) to a decrease of 70 Gt CO₂ (SSP1), equivalent to an increase of 26 ppmv and a decrease of 9 ppmv CO₂ in the atmosphere respectively.

Land-based mitigation measures are an important component of ambitious climate mitigation scenarios. The implementation of options such as bio-energy, reforestation, REDD, agricultural intensification or dietary change have large potential. However, the net impact depends highly on the context of implementation. Socio-economic trends and non-land climate mitigation substantially affect the land-based mitigation potential, which is highly location-dependent. IMAGE analyses show the potential of a range of mitigation options. An example is the implementation of REDD in an SSP1 scenario with ambitious climate mitigation, where areas with large carbon stocks are protected. This results in additional intensification of agricultural land due to limited land availability, and a shift of agricultural expansion to areas with lower carbon stocks. Due to this measure, carbon emissions are reduced by 87 Gt CO₂, equivalent to 11 ppmv CO₂ in the atmosphere.

Next to biogeochemical climate effects, biophysical effects of LUC have a substantial impact. Regionally, the net temperature effect of changes in the land energy balance due to differences in albedo or evapotranspiration can be in the same order of magnitude as projected global warming. The location of change is very important, as deforestation in the tropics can lead to a surface warming of 0.5–1 degrees compared to a surface cooling in the highest latitudes of 3–4 degrees (Davin & Noblet-Ducoudré). The location of the LUC is key, with the SSP4–5r outlook. In the case of re-forestation, the biophysical effects of the SSP land use projections will be studied in collaboration with earth system models.

P-2217-09

Genetic diversity of perennial grass species in response to temperature during germination

A.J. Escobar Gutiérrez (1); LQ, Ahmed (1); J.L. Durand (2)

(1) INRA, Lusignan, France; (2) INRA, Environnement et Agronomie, Lusignan, France

Grasslands cover more that 40% of earth’s surface and at least 30% of the 160 Mha Agricultural Surface Area of Europe. They are among the largest ecosystems on earth and one of the major sources of forage. Further, in the context of climate change, grasslands are considered, together with forests, as carbon sinks for atmospheric CO₂. The agricultural use value of grasslands depends on their floristic composition and the structure of their canopy. These two intertwined features directly determine the quality of the forage, the biomass production due to grazing or mowing, perennial ryegrass (Lolium perenne L.), tall fescue (Festuca arundinacea Schreb.) and cokfoot (Dactylis glomerata L.) are the major perennial grass species in temperate and Mediterranean regions. However, during the lifespan of grassland, both floristic and genetic composition as well as canopy structure evolve under the influences of environmental factors and the management practice. The overall survival and reproduction of individual plants and genetic composition evolves because of individuals’ mortality and recruitment of new species and genotypes from the soil seed-bank or natural sowing. Temperature is one of the major factors controlling plant development rates (i.e. plant phenology, organogenesis and expansive growth). It is important in controlling seed germination. Indeed, higher plant species, as well as populations, varieties and cultivars within species, respond differently to temperature during the critical period of germination and seedling establishment in the field. It is vast on this subject that is always a topical issue. In the context of global change, breeding grasses adapted to new ranges of temperature could be necessary. Knowing the variability of responses to temperature by different accessions of germplasm is an unavoidable first step towards such breeding. Thus, the objective of the work presented here was to analyse the genetic variability of L. perenne, F. arundinacea and D. glomerata in response to temperature during germination.

Eight populations of L. perenne L., nine populations of F. arundinacea and six populations of D. glomerata were evaluated. Four replicates of one-hundred seeds per population were tested for germination in the dark under eight single temperature regimes between 5 and 40°C with a unitary temperature range of 1°C. Optimal temperature for germination ranged from less than 10°C to 26°C. Further, it was observed a differential sensitivity to our extreme treatments (5 and 35°C).

Overall, these results demonstrate that genetic variability does exist within the three studied grass species for response to temperature during germination. This should provide additional evidence to protect populations at risk and extend to other processes the analyses of response to temperature, and ii) plant breeders to collect and analyse populations of grasses from sites with extreme environmental conditions. We suggest that seed germination of L. perenne, F. arundinacea and D. glomerata in response to temperature during germination.

P-2217-10

Land Degradation and Resource Based Economy – A Case Study in Indian Sunderbans

T. Ghosh (1); S. Saha (1)

(1) Jadavpur University, School of Oceanographic Studies, Kolkata, India

The Indian part of Sunderbans is highly vulnerable due to climate change impacts like sea level rise, erosion, salinization of coastal soil and water, coastal and river flooding and subsequent land inundation every year. The inhabitants solely depend on the traditional primary activities depending on natural resources such as fishing and animal husbandry for their sustenance. In agriculture, mono-cropping is the only way in which local economy. The situation has become worsen after coastal flooding and subsequent land inundation in 1970. But also by burns that affect the local economy. The situation has become worse since the cyclone ‘Aila’ on 25th May 2009, when extreme level of inundation left behind saline water stagnation for a considerable time causing substantial damage on the productive soil, leaving the land unproductive for longer time. Consequently, change in land-use pattern as well as change in occupational structure has observed. Minimal efforts to switch over to other activities and other variants of vegetables and fruits traditionally grown are found insufficient. Hence, the workforce in the community finds agriculture as a ‘loss business’ and lacking any other alternate skill they intend to migrate as a
Spatial and temporal uses of land as affected by global change: a focus on Mediterranean agriculture

C. Giupponi (1) ; V. Mojtahed (1)
(1) Ca' Foscari University of Venice, Venice Centre for Climate Studies, Venezia, Italy

At the global level, climate and socio-economic changes determine the patterns of the allocation and trade of resources in all markets. Top-Down computable general equilibrium models, which only economics factors of production (capital and labour mostly) and ignoring natural resources constraints, look at the effects of global trends and generate trajectories of socio-economic indicators, such as prices of commodities in the global markets, volumes of trades, gross products per country and sectors. Those models are commonly used to analyse the evolution of global economies, under the pressure of climate change drivers, but their approach impose substantial simplifications in terms of spatial aggregation and limited consideration of temporal variabilities.

When considering adaptation of social and ecological systems to climate change, their inherent complexity and non-linearity and spatial and temporal variabilities put the usefulness of consolidated CGe approaches under question. As a consequence, other methodological approaches are explored, and in particular more and more scholars adopt a bottom-up approach, which utilizes agent-based models (ABM). ABM’s embrace a much finer spatio-temporal detail, in particular, with the ambition to analyse the behavioural diversity of agents, as a consequence of their diverse interactions with the surrounding environment and their bounded perceptions of the changing world.

This work explores the potential for integration of the two approaches, with ABM models being used to simulate land use change dynamics, with consideration of spatial (i.e. territorial) and temporal (i.e. climatic extremes and economic shocks) variabilities, driven by CGe models providing the macro-economic trends under the effects of global change scenarios.

We focus on how global change may affect land-use allocation at the regional level, under the influence of limited natural resources, land and water in particular. We specifically explore how constraints and competition for natural resources may induce non-linearities and discontinuities in agro-ecosystems behaviour.

With the purpose to develop an approach that could be implemented worldwide as a means for zooming down from the global to the regional scale, an ABM prototype was developed and run with readily available global databases in three [VM1] test areas around the Mediterranean Basin, in agricultural regions of Morocco, Italy and Spain [VM2]. Starting with extremely simplified and averaged settings; we sequentially introduce the available information about spatial and temporal variability and simulate the dynamic of land use changes in terms of improved integrated multi-scale simulation of global change scenarios and economic development.

Low Emission Development Strategies in Agriculture. An Agriculture, Forestry and Other Land Uses (AFOLU) Perspective

A. Haruna, (1) ; A. De Pinto (1) ; G. Hyman (2) ; J. Tapasco (2) ; B. Rutten (3) ; A. Popp (1) ; J. Dietrich (1) ; F. Humpenöder (1)
(1) International Food Policy Research Institute, Washington, DC, United States of America; (2) International Center for Tropical Agriculture, Cali, Colombia; (3) International Food Policy Research Institute, EPT, Washington, DC, United States of America

Resource use in many developing countries, from crop production to deforestation, emits significant amounts of greenhouse gasses (GHG) emissions. We also know that there are instances in which the agricultural and forestry sectors can provide low-cost climate change mitigation opportunities. From a technical point of view, the expected increases in GHG emissions in agriculture requires the adoption of transformative approaches in the use of resources. A growing body of literature analyzes the effects of alternative agricultural production and livestock sector has also been the target of research on mitigation opportunities and the mitigation potential of forests, soil and other biomass, has been amply analyzed as well. However, from a policy-making perspective, the challenge at hand is to reconcile the limited spatial resolution of macro-level economic models that operate at a subnational or national level with models that function at a higher spatial resolution, which allows for proper accounting for changes in agricultural land use and GHG emissions. To our knowledge there are only a few examples of analyses with similar objectives: Golub et al (2013) examined the impact on food consumption and income of implementing policies targeting deforestation in regional levels. Schneider et al (2008) estimated mitigation potentials of U.S. agriculture with regionally disaggregated data and changes in welfare within the agricultural sector. Rusticucci et al. (2014) estimated the effects of climate change and economic growth scenarios on Vietnam’s economy. Havlik et al. (2014) estimated the effects of transitioning to more efficient livestock production system on GHG mitigation and the economy. In this work we demonstrate that different models, all widely accessible to the public, can be brought together to help policymakers in their evaluation of opportunities and repercussions of alternative mitigation policies in the agricultural sector. While the focus of this work is on Colombia, the analytical framework can be applied to any country interested in analysing how climate change and economic viability of climate change mitigation policies in agriculture. The approach is based on the use of public and widely accessible data and we believe that the flexibility and transparency of the approach proposed in this study can increase decision-makers’ trust in the results. It appears clear from our analysis that policymakers need substantial support in their decision-making process as the range of options they face can be very diverse and the effects of their decisions have important, and sometimes unexpected, repercussions. The effects of the policies we simulated cover the entire spectrum of potential outcomes, from extreme socioeconomic shocks to the complexity of low emissions development strategies, modeling approaches, frameworks, and tools should be adaptable, open, and transparent. Modeling frameworks should be adaptable so that policymakers can better understand the consequences of using different data sets and incorporate new information as it becomes available. Modeling frameworks and tools should be open to the inclusion of insights from different models to provide a more robust assessment of the results can be assessed. We believe that the modeling framework proposed in this work fits these characteristics. Stakeholders, from government agencies, to producer and consumer organizations to the public will benefit from policies devised with the support of solid evidence and the effects of which can be investigated and evaluated by all the parties affected.

Implications of bioenergy production under various future land system pathways

F. Humpenöder (1) ; A. Popp (1) ; J. Dietrich (1) ; B. Rutten (1) ; A. De Pinto (1) ; A. Haruna (1) ; G. Hyman (2) ; J. Tapasco (2)
Bioenergy use in the energy sector, particularly in combination with carbon capture and storage (BECCS), plays a key role for reaching ambitious climate targets. But the large-scale production of bioenergy, which predominantly requires considerable amounts of fertile land and water (Bonsch et al., 2014, GCB Bioenergy), can have side effects on land–use dynamics, land–related GHG emissions and food prices. For instance, CO2 emissions from deforestation associated with bioenergy production could lower the mitigation effect of bioenergy use in the energy sector (Popp et al., 2012, Ecol Econ). However, avoiding land-use change and associated CO2 emissions due to bioenergy production could result in higher prices for food (Popp et al., 2011, Environ Res Lett) and also bioenergy (Klein et al., 2014, Environ Res Lett). There is a huge body of literature on bioenergy and transgressions with climate protection, sustainability and food security goals (Creutzig et al., 2014, GCB Bioenergy). However, most of these publications focus on single aspects, while a comprehensive and consistent analysis taking into account various uncertainties of future land system pathways, such as future food demand, development of agricultural yields, and availability of land for agricultural expansion, is still missing.

In this study, we analyze the implications of bioenergy production under various future land system pathways with the tools of the spatially explicit land-use optimization model MAGPIE. Our general scenario setup is based on SSP2 (O’Neill et al., 2015, Glob environ Chang) and includes global bioenergy demand (2nd generation) that increases linearly to 300 eJ by 2100. We assess the global medium to long-term implications of bioenergy production in terms of land–use dynamics, associated GHG emissions, and bioenergy and food prices. How these environmental and socio–economic indicators evolve under bioenergy production throughout the 21st century depends on key characteristics of the future land system. We test the sensitivity of these indicators to the following land system parameters that directly or indirectly affect bioenergy production: future bioenergy yields (irrigation, feedstock availability), pricing of land–related GHG emissions, forest protection, trade liberalization, future food demand, and productivity increases in the agricultural sector. Finally, we identify trade–offs and synergies related to bioenergy production along the analyzed future land system pathways.

Our results show, for instance, that GHG emission pricing strongly reduces deforestation related to bioenergy production, while CO2 emissions from land–use change are lower under GHG emission pricing. However, bioenergy as well as food prices considerably increase with GHG emission pricing due to competition for land. Thus, this results in land–based mitigation via bioenergy and food security: low CO2 emissions from land–use change coincide with high food prices, while high CO2 emissions from land–use change coincide with low food prices.

Disturbance climate in Eastern of Democratic Republic of the Congo

M. Kasangala Junior (1); MN. Mugeruza (2)
(1) National Institute of Agronomic Studies and Climate Research, Geography, Uvira, South–Kivu Province, Democratic Republic of the Congo; (2) Higher Technical Institute of Rural Development, Geography, Uvira, Democratic Republic of the Congo

In DR Congo, in South – Kivu province, specifically in the territory of Uvira, Fizi, Mwenga and Shabunda, the influx of Rwandan and Burundian refugees in 1992 and 1994. And the population displacement caused by war 1996 and 1998 have increased the area fell of tropical forests therein and practice of bushfire. These trees were felled every day to serve as firewood, construction and service to millions of people and bushfire caused to easily obtain fuel. Firewood capture with animal and individual aims. Naturally, this region comprises 5 ecological zones which are the coastal plain, the tray means, the highlands and woodland. The region also has two climatic seasons including the rainy season which extends from September to June and the dry season which lasts 2 months, all the months of July and August of each year. The environment in this part has been degraded due to massive deforestation and practice bushfire. These two negative factors were the basis for the deterioration of the climate in this part of country. These massive cuts uncontrolled wood and unquantified and bushfire caused few years later in 2006 and 2007 climate change ever experienced in this region. This climate change caused the disruption of the agricultural calendar and a sharp increase in heat. Crop period would normally start with the beginning of the rainy season in September was postponed in December or January. The rain was almost rare throughout the region during this period, and once she fell here and there on bare soil where water carried everything in their path. The flow of many rivers has decreased significantly and the most of the rivers dried up. A period of temporary drought was established. It was suffocating for lack of water everywhere. Meteorological services of the country gave each time the alert climate of the region where the temperature still ranged between 30 and 35 °C. Many people have fallen ill and many children died of this climate change. Many wild and domestic animals perished. The plant diseases have been developed, particularly called cassava mosaic disease appeared. This disease has made cassava much less productive while cassava is the staple food most consumed in the middle. The plants were dried by lack of water. Famine is installed around the region. Groups of people moved themselves further into the forest in search of more productive and reassuring for survival places. Alarm calls initiated by local leaders, civil society, and development organizations on the climatic disturbance in that region has allowed political authorities and non–governmental organizations of development to get involved to stop all this ecological and climatic catastrophe.

Addressing climate change mitigation and adaptation together: A global assessment of agriculture and forestry projects

R. Kongsager (1); B. Locatelli (2); F. Chazarin (2)
(1) UNEP DTU Partnership, Copenhagen, Denmark; (2) Center for International Forestry Research (CIFOR), Lima, Peru

Adaptation and mitigation share the ultimate purpose of reducing climate change impacts. However, they tend to be considered separately in projects and policies because of their different objectives and scales. Agriculture and forestry are critical components of such projects and policies, and they contribute to greenhouse gas emissions and removals, are vulnerable to climate variations, and form part of adaptive strategies for rural livelihoods. We assessed whether climate change projects in forestry and agriculture integrated adaptation and mitigation, by analyzing 201 projects from adaptation funds (e.g., UNFCCC Adaptation Fund), adaptation plans (e.g., National Adaptation Program of Action), and project standards (e.g., Climate Community & Biodiversity (CCB)). We analyzed whether projects established for one goal contributed explicitly to the other (i.e., whether mitigation projects contributed to adaptation and vice versa). We also examined whether their activities or expected outcomes adhered strongly to one of the two goals. Despite the separation between the two goals in international and national institutions, 37% of the project documents explicitly mentioned a contribution to the other
objecive, although only half of those substantiated it. In addition, most adaptation (90%) and all mitigation projects could potentially contribute at least partially to the other goal. Some adaptation project developers were interested in mitigation for the prospect of carbon funding, whereas mitigation advocates proposed adaptation to achieve greater long-term sustainability or to attain CCf certification. National and international institutions can provide incentives for projects to harness synergies and avoid trade-offs between adaptation and mitigation.

P-2217-16
Legacy effects of repeated land-use changes in the LPJ-GUESS dynamic vegetation model
A. Krause (1) ; A. Arneth (2) ; A. Bayer, (3) ; M. Lindeskog, (4) ; TAM. Pugh (3)
(1) KIT, Imk-ifu, Garmisch-Partenkirchen, Germany; (2) KIT, Atmospheric Environmental Research, Garmisch-Partenkirchen, Germany; (3) Karlsruhe Institute of Technology, Imk-ifu, Garmisch-Partenkirchen, Germany; (4) Lund University, Lund, Sweden
This contribution is aimed at the session «Global scenarios of land-use change and land-based mitigation, and their importance in the climate system» - conveners Arneth/ Stehfest/Popp.

Natural terrestrial ecosystems store large amounts of carbon in living biomass and soils. During the last centuries, agricultural harvest and deforestation of primary forests for pastures and croplands greatly altered carbon, water and nutrient cycles and thereby also affected secondary vegetation dynamics after the cessation of agriculture. Historically most terrestrial biosphere models have only accounted for net changes in land-use aggregated at coarse scales of 0.5° or more. However, the extent to which finer-scale details of land-use change dynamics, particularly the detailed land-use history of a site, influence ecosystem and carbon dynamics is not well understood. In this study we investigate the legacy effects of repeated land cover transitions between natural vegetation, croplands and managed forests over different time intervals in the LPJ-GUESS dynamic vegetation model. We identify the extent to which land-use transitions are reversible, and quantify lags in system response, finding that these results are strongly dependent on the land-use history. Implications for regional and global scale estimates of land-use change emissions and the feasibility of reforestation projects to sequester carbon are discussed.

P-2217-17
A Cascade Modeling Approach to the Assessment of Climate Induced Land Use Change
A. Lungarska (1) ; PA. Jayet, (1)
(1) INRA, Economie Publique, Thiverval-Grignon, France
Land use and land use change are inherently related to climate change (Pielke, 2005). Furthermore, they are interconnected as each one is influencing the other. In this study we assess the effects of climate change on human activities, namely agriculture and forestry, and the resulting land use and land use change for France. Our modeling approach combines sector-specific mathematical programming models and statistical tools in a multitarget algorithm framework, allowing for the quantification of climate change effects on agricultural and forestry activities. Models are used to capture specific aspects of climate change, namely harvest and deforestation dynamics in the LPJ-GUESS model. Results obtained are used to improve the modeling approach of the second modeling stage. They are exploited as parameters in economic models for the two sectors: the agricultural supply-side model AROPaj (Galko & Jayet, 2011) and the partial equilibrium model of the French forestry, FFSM + (+) (Galko et al., 2013). These two models allow us to evaluate the potential gains for their corresponding sectors. The final, third, step of our modeling approach consists in an econometric (statistical) land use change model where agricultural and forestry rents are approximated by the results from the sector-specific models. Thus, we can estimate land use shares of five major categories: (i) agriculture, (ii) forestry, (iii) urban, (iv) agriculture and forestry, and (v) other; at the scale of a homogeneous grid with resolution of 8 km x 8 km covering metropolitan France for the period 2000 – 2100. The major advantage of our modeling approach is that it accounts for variation in biological productivity due to climate change and at the same time it can test different socioeconomic scenarios such as new price vectors, management practices and public policies.

References:

P-2217-18
Geoinformation-based morphometric flood risk and vulnerability analysis of Kubwa settlement, Abuja
Mi. Mammadov (1) ; C. Christopher (2) ; M. Thiel, (2) ; D. Alfred (3) ; SA. Halliu (4)
(1) Kwame Nkrumah University of Science and Technology, (KNUST), Civil engineering department - grp climate change and land use, Kumasi, Ghana; (2) Institute of Geography and Geology, Remote sensing, Wurzburg, Germany; (3) College of Engineering, Geomatics Engineering and Geoinformation, Kwame Nkrumah university of science and technology, Kumasi, Ghana; (4) National Space Research and development Agency (NASRDA), Strategic space applications, Abuja, Nigeria, Federal Republic of Nigeria
Natural landscapes have profoundly been changed due to human activities. In particular, land use and land management change affect the hydrology that determines flood hazard. In this research, the use of historical remote sensing data is used to assess the vulnerability of people and places to potential risk associated to settlements especially from flooding events linked to lowland and floodplains. The motivation for this study is that global trends of disaster occurrences are on the increase in urban cities and peri-urban settlements. Hence there is urgent need to assess the vulnerability of places and people to natural hazards such as flood risk especially in developing countries to improve disaster risk reduction (DRR) programs. For this purpose, a geoinformation-based approach is adopted to initially map land cover change of Abuja and environ and to understand settlement morphology, and identify settlement such as floodplain vulnerable areas (low livelihoods community). The ETM + (OLI) image series from 1986, 2001 and 2014 were used to generate retrospective and contemporary landscape maps using support vector machines (SVM). To unlock changes in plan implementation, result of the remote sensing-based land use maps was compared to the original land use map. It was apparent that residential areas have increased remarkably by more than 50%. To determine built area encroachment into the flood zone and floodplains, identify and classify the area into the different levels of vulnerability, a floodplain morphometric information extraction from public domain satellite-based DLR geohazard models. One such as flood susceptibility due to landscape as well as climate extreme events. Finally, the assessment revealed that the central part of Kubwa, is largely a lowland which is observed to be densely populated and is most affected by flood incidences due to soil sealing resulting to poor infiltration. Other characteristics include settlement encroachment into the flood zone and floodplains, clogging of the drains and lack of land use planning. The outlook of this study therefore recommends the need for geospatial land use planning, improved drainage infrastructure in delineated high risk zones, enforcement of standards and codes, community education/ participation, among others.

P-2217-19
Urban Land Use Change Effects on Coastal Forest Ecosystem: A Case of Dar es Salaam, Tanzania
A. Masanja (1)

(1) Institute for Environment and Development Studies, Environment, Dar es Salaam, Tanzania, United Republic of

This study assessed the impacts of coastal urban land use change on climate change of coastal forests. The study analyzed the impacts of climate change on coastal livelihoods and their implication on coastal forest degradation; the impacts of coastal urban and peri-urban ecosystem services; and the participatory rural appraisal using questionnaires and key interviews was applied to assess the impacts of land use changes on coastal forest ecosystem surrounding communities particularly impacts on coastal livelihoods.

The study found that change in land cover from vegetation to residential buildings and paved land surfaces due to urban land use alters completely the functional properties of land including its ecosystem services that exists before changing the land use. In addition to the impacts of land use change due to urban development, the growing urban population is directly linked to the surrounding as well as distant forest ecosystem services. The shift in livelihoods of communities from coastal to forest based activities due to impact of climate change on coastal environmental services. However, in this study we have not been able to assess the pressures of urban and peri-urban growth and livelihood activities on coastal forests contributes to coastal deforestation and forest degradation.

This study concludes that land use changes in settlements that surround ecosystems have caused changes in ecosystem services. However, change in land uses is highly caused by population growth because when one more person enters a new area, creates demand of an area for shelter and an area for performing activities for livelihood. This process affects the human ecology, economy, and security of a community. Therefore, the study concluded that land use changes in settlements have caused changes in ecosystem services. This change in land use has adverse effects to the ecosystem services. Dar es Salaam watershed ecosystems which were once a home for millions of various biodiversity species have been affected by land use/cover changes in surrounding urban and peri urban areas. The study recommended for an integrated ecosystem approach to mitigate the impacts of land use change on forest ecosystem.

P-2217-20

Significant Contribution of Oil and Gas Industries in Temperature Increasing in Northern Coast of the Persian Gulf

H. Moradi (1) ; AA. Malekizadeh (2)

(1) Isfahan University of Technology, Department of Natural Resources, Isfahan, Islamic Republic of Iran; (2) Isfahan University of Technology, Department of natural resources, Isfahan, Islamic Republic of Iran

Pars Special Economic Energy Zone (PSEEZ) was established in 1998 for the utilization of South Pars oil and gas resources. The gas resources of PSEEZ is about 9% of all gas reserves exist in the world. Since the operation at the PSEEZ is active. It is planned that the PSEEZ will have about 28 phases of refineries and petrochemical plants. Before coming oil and gas activities to the region, the region was a habitat for many mangroves forest, mudflats, coasts, wetlands, rangelands, farm lands, etc. Although all the phases are not operating but the landscape totally has been changed. Usually, the industrial activities causes increase in the local temperature directly (e.g. stacks and flares) or indirectly (landuse/cover changes). In this paper, we studied the landuse/cover changes as well as the temperature increase of a particular area from 1998 to 2013. To do this, we used the Landsat 5 TM and Landsat8 (OLI) satellite images between May 1998 (Before construction started) and May 2013 (after 10 years operation). We made the temperature maps from Infrared thermal bands (i.e. TM 6 and OLI 10). Our results showed that a 100% increase in industrial zones and flares areas, a decrease of 34.11ha in mangroves cover (mostly in Basatin Bay), and a decrease of 12864 ha in natural rangelands (mostly in mountain-like looking to industrial zones) are the major changes. However, the wastewater releases from Phases 9 and 10 could be a reason to destroy the mangroves. Marine water resources in our study area have been decreased by 1761.7 ha where 1509 ha has been changed to bare lands and 119 ha to industrial zones. This decrease is because of filling the shallow waters and drying the Mohr River. Moreover, the wastewater emissions from the industrial zones have been increased from 4832 ha in 1998 to 418 ha in 2013. Comparing the landuse/cover changes with the temperature map revealed a positive correlation. The results showed that the mean temperature increase by 2.86 C from May 1998 to May 2013. The findings showed that temperature ranges are different in two dates where in 1998 is between 24C–55C and for 2013 is between 25C–61C. Moreover, in 1998, temperature class 26C had covered the most area in the studied area by 34224 ha where this has decreased to 24416 ha in 2013. In 1998, in overall, only 7400 ha had the temperature lower than 26C but in 2013 only 5 ha. In 1998, the area of the temperature class 37–44C was about 68366 ha which is decreased to 18852 of 2013. The area of temperature class of 45C–49C this time period did not changed and was about 60000ha. Therefore, the major changes in area of temperature class happened in 50C–55C which increased from 10569ha in 1998 to 56760 ha in 2013. In 1998, the last temperature which is observed in the study area is 55C with 25 ha but in 2013 we observed a new temperature class of 55C–61C with 3824 ha. If we have a closer look at the landuse/cover changes map and temperature map, we could found that changing the shallow waters to bare and industrial lands caused an increase of about 28% to 72% in crops and bare lands. On the other hands, the dry the wetlands for industrial lands has been caused an increase of about 3C to 6C where this increase because of the increasing in the temperature of Mohr River is about 14C. Our results revealed that although the industrial development and its activities has a direct impacts on local temperature but the landuse/cover changes coming by the development has also a major impacts.

P-2217-21

Agriculture and livestock under the effects of climate change

M. Nofuentes Ramos (1); L. Cañas Ramirez (1); J.A. Morgui (1); E. Gazquez (1); A. ÁGueda (1); P. Occhipinti, (1); C. Grossi, (1); R. Curcoll (1); O. Batel, (1); S. Borràs, (1); X. Rodó (1)

(1) Institut Català de Ciències del Clima, Barcelona, Spain

Current practices in agriculture and livestock are closely linked with climate change. Surplus nitrogen use agriculture and intensive livestock production represent a major contribution to the increasing concentrations of various greenhouse gases (GHGs). Moreover, climate change affects crops and farms around the world, due to increased temperatures, weather extremes and incidence of floods and droughts.

Agriculture represents one of the main emitters of nitrous oxide (N2O), methane (CH4) and ammonia (NH3). Farming in the EU now accounts for 7% of global emissions of GHGs. Since the second half of the twentieth century the increased use of nitrogen fertilizers resulted in losses of nitrogen into the water and into the atmosphere. Intensive livestock production contributed to the emissions of methane (CH4).

Rising temperatures, reduction of water resources in many areas, changes in the frequency and distribution of rainfall, droughts and floods, etc., directly affect agriculture. Every one of these changes may cause the agricultural production in certain areas as much as traditional crops are abandoned and lost for future climate adaptation. Increases in temperature will help pests and diseases to proliferate in crops with a consequent reduction in both the quantity and quality of agricultural production.

Furthermore, livestock production is directly affected by climate change and loss of biodiversity. Climate change affects more illimes and stress as a consequence of a decrease in grazing and grazing time as less rainfall will disrupt the seasonal availability of pastures. Disturbances over crop forage will reduce the livestock production while increasing production costs.

We open the debate on livestock production and their effects on ecosystem metabolism (missions of GHGs) by
discussing the production capacity of traditional practices of crops and grazing (forest burning, intensive pastures, seasonal migration) and severe climate has shaped the landscape. As an applied use of GHGs monitoring from the ClimDat Project, we will debate the variability in mitigation of greenhouse gases emissions by different options of land use management.

P-2217-22

New global land use under climate change and freshwater restrictions

A. Pastor (1); A. Palazzo (2); F. Ludwig (1); P. Havlik (2); P. Kabat (2)

(1) Wageningen University, Wageningen, Netherlands; (2) IASS, Laxenburg, Austria

Allocation of agriculture commodities and water resources is subject to changes due to climate change, population increase and changes in dietary patterns. This study focused on including global water availability including environmental flow requirements with water withdrawal from irrigation at a monthly time-step in the GLOBIOM model. This model allows re-adjustment of land use, crop management, consumption and international trade. The GLOBIOM model predicts an endogenous change in water price depending on water supply and demand. In this study, the focus was on how the inclusion of water resources effects land-use and, in particular, how global change will influence repartition of irrigated and rainfed lands at global scale. We used the climate change scenario including a radiative forcing of 2.6 W/m² (RCP8.5.,) and the environmental flow method based on monthly flow allocation (the Variable Monthly Flow method) with high and low restrictions. Irrigation withdrawals were adjusted to a monthly time-step to account for environmental water requirements at a shorter time resolution. Our results show that irrigated land might decrease up to 40% on average depending on the choice of water resources. Several areas were identified as future hot spots of water stressed such as the Mediterranean and Middle-East regions and parts of South-East Asia where the Water Stress Indicator (WSI) varies from 0.4 to 1 by 2050. Other countries were identified to be in safe position in terms of water stress such as North-European countries. Some countries such as India expect a significant increase in water demand which might be compensated by an increase in water supply with climate change scenario. Reallocation of rainfed and irrigated land might be useful information for land-use planners and water managers at an international level to decide on appropriate legislations on climate change mitigation/adaptation when exposure and endogenous climate change is considered and/or on adaptation measures to face increasing water demand. For example, some countries might be able to adopt measures to increase their water use efficiencies (irrigation system, soil and water conservation practices) to face water shortages, while others might consider improving their trade policy to avoid food shortage.

P-2217-23

Metrics for the net climate effect of land use change in support of land based mitigation and adaptation policies

L. Perugini (1); A. Arneth (2); A. Cescatti (3); N. De Noblet-Ducoudré (4); G. Grassi (5); J. Houboul (6); B. Quevauviller (2); E. Robertson (7); M. Santini (1); A. Wiltshire (7)

(1) Euro-Mediterranean Center on Climate Change, Division on Climate Impacts on Agriculture, Forests and Ecosystem Services (IAFES), Viterbo, Italy; (2) KIT, Atmospheric Environmental Research, German-Polish Partnership, Kiel, Germany; (3) Institute for Environment and Sustainability, Climate Risk Management, Ispra, Italy; (4) Laboratory of Evaluation of the Environment, CEA-CNRS-UVSQ, Gif-sur-Yvette cedex, France; (5) European Commission, Joint Research Centre, Forest resources and climate unit, Ispra, Italy; (6) University of Bristol, School of Geographical Sciences, Bristol, United Kingdom; (7) Met Office Hadley Centre, Exeter, United Kingdom

Land Use and Land Cover Changes (LULCC) have a recognized effect on climate, both in terms of changes in the carbon cycle due to changes in vegetation and soil carbon (biogeochemical effects) and through variations of the surface energy budget mediated by albedo, evapotranspiration, roughness etc. (biophysical effects). While the increase of greenhouse gas (GHG) concentration in the atmosphere affects the climate in the long term and at global scale, biophysical effects result in short-term changes in seasonal and/or annual surface temperatures with a prevalent local to regional effect. In addition, the climate signal of biogeochemical processes is independent of the geographical location of the LULCC, whereas biophysical effects vary greatly in sign and magnitude depending on the latitude and ecosystems where they occur. For example, observations and model results suggest that deforestation has a predominantly warming effect in the tropics due to reduced evaportranspiration, exacerbating GHG effects, and a cooling effect in the boreal regions in the winter due to increased albedo, large effect with some warming effects due to reduced evapotranspiration in the boreal summer.

The international policy process within the United Nation Framework Convention on Climate Change (UNFCCC) focuses entirely on GHG and their global effects. At the local level a combination of the global biogeochemical and local biophysical effects following LULCC are important for local climate, ecosystems, their biodiversity and the water cycle. Policies at the local to regional level that aim to address both mitigation and adaptation objectives might be less effective if they ignore the synergies and tradeoffs between biogeochemical and biophysical effects.

The paper presents a tool of practical use in support of assessment of mitigation/adaptation land policies, allowing a straightforward comparison of the estimated climate impacts of different LULCC transitions. Through a meta-analysis of the existing scientific literature, we quantified how the LULCC-climate change interplay affects regional vs. global scale, and biophysical vs. biogeochemical ecosystem-atmosphere exchange, providing a simple climate metric that sums up the changes in temperature and precipitation following LULCC. Compared to alternative approaches proposed so far, our strategy was to focus on the regional climate signal rather than the global average effects, considering that ecosystems and communities are affected and have to adapt to local climates.

P-2217-24

Land use response to the climate change in the Great Hungarian Plain?

Z. Pinke (1)

(1) Szént István University, Environmental Protection and Landscape Ecology, Gödöllő, Hungary

This poster presents the concept of interactions between environmental conditions and the productivity as well as the extension of Hungarian arable lands.

Firstly, a descriptive analysis demonstrates the synchrony of the tide of arable lands and climate change. Hungary lies on the border of hot and warm summer subtypes of the humid continental zone. Its plains were transformed into homogeneous grain-producing regions during the 20th century modified by North-European countries and international water regulations. As I see the humidity of the late and post-Little Ice Age (between the mid 1870s and the mid 1940s) was an important factor in process of this landscape transformation. On the one hand, the late 19th century Hungary replied to the increased flood-hazard with the intensification of river regulation. On the other hand, the relative precipitation surplus of the humid cycle probably resulted in the growth of the Great Hungarian Plain (GHP), thus providing a low risk opportunity to convert waterlands into tillages in tens of thousands of square kilometres. The extension of arable lands reached the saturation level of the 1913 and mid 1940s, while the beginning of their decrease overlapped precisely with the end of the humid climatic cycle. This decline has been going on in Hungary since the late 1940s. As a part of this process the excessive agricultural water inundations have led to the rapid abandonment of croplands in huge areas (e.g. 1952, 1963, 1999, 2010).

Secondly, the paper presents the results of statistical examinations of seven crops – barley, corn, oats, potato, rye, sunflower, and wheat – losses due to droughts and exceed surface water events at a national and a county scale between 1921 and 2010. The relationship between
the Pálfai Drought Index (pDAI), extension of inundated areas and annual crop yields was examined by ANOVA, the differences between crop yields in counties by t-test at a 5% significance level. It is an important methodological aspect that the annual yields of periods with high pDAI and the drought indices within them were compared. Years with extreme yield fluctuations in wartime events (1944–45), technological transition (e.g. 1959–1975), transformation of property and economic structure (1990–1998) were eliminated. Thus, besides 30 years long meteorological periods (1921–1950, 1951–1980, 1981–2010), four homogenized technological periods were created (1921–1938, 1946–1958, 1976–1989, 1991–2010).

The closest relationship appeared between crop yield losses and values of the drought index in periods with high pDAI. The period with the highest deviations within them was characterized by three long periods indicate a long-term trend towards an increasing frequency of extreme droughts since the late 19th century. The technological period (1991–2010) when the standard deviation of drought indices is the highest in the examined 90 years, the yield losses of five out of seven crops indicate a significant and close relation to pDAI values. These results indicate a major transformation in the meteorological conditions of cropland farming. Over the last one and a half decades extreme droughts and inundations have alternated rapidly. Corn deserves a special attention for several reasons. Besides wheat, it is corn that has the most extensive harvest area in Hungary. In the past decade it covered some 26–28% of Hungarian croplands. Since growing season of corn (June–August) is highly exposed, the fluctuation of corn yields showed a close linear relation to drought indices in three out four technological periods and in the three 30-year long periods (e.g. between 1981 and 2010 R²=0.78; y = -0.4657x + 8,3674; 30 couples).

The most conspicuous phenomenon is that more extrems happened in the last two decades than in the former seven decades. The variability of the climatic variability on the crop yields has been more and more apparent in the regression coefficients. It is partly for this reason that the average yields of the most drought-prone counties that lies in the GHP and covered the majority of former floodplains fall below the national average. Such a high level of exposure to drought fundamentally queries the economic rationale of cropland farming, led to the abandonment of vast areas of cropland and justifies the objective of the European of cropland farming, led to the abandonment of vast areas of cropland and justifies the objective of the European Union to reduce EU’s share in global greenhouse gas emissions by 20%.

The yield losses as a result of droughts indicate a major transformation in the examined 90 years, the yield losses of five out of seven crops indicate a significant and close relation to pDAI values. These results indicate a major transformation in the meteorological conditions of cropland farming. Over the last one and a half decades extreme droughts and inundations have alternated rapidly. Corn deserves a special attention for several reasons. Besides wheat, it is corn that has the most extensive harvest area in Hungary. In the past decade it covered some 26–28% of Hungarian croplands. Since growing season of corn (June–August) is highly exposed, the fluctuation of corn yields showed a close linear relation to drought indices in three out four technological periods and in the three 30-year long periods (e.g. between 1981 and 2010 R²=0.78; y = -0.4657x + 8,3674; 30 couples).

The most conspicuous phenomenon is that more extrems happened in the last two decades than in the former seven decades. The variability of the climatic variability on the crop yields has been more and more apparent in the regression coefficients. It is partly for this reason that the average yields of the most drought-prone counties that lies in the GHP and covered the majority of former floodplains fall below the national average. Such a high level of exposure to drought fundamentally queries the economic rationale of cropland farming, led to the abandonment of vast areas of cropland and justifies the objective of the European Union to reduce EU’s share in global greenhouse gas emissions by 20%.

The yield losses as a result of droughts indicate a major transformation in the examined 90 years, the yield losses of five out of seven crops indicate a significant and close relation to pDAI values. These results indicate a major transformation in the meteorological conditions of cropland farming. Over the last one and a half decades extreme droughts and inundations have alternated rapidly. Corn deserves a special attention for several reasons. Besides wheat, it is corn that has the most extensive harvest area in Hungary. In the past decade it covered some 26–28% of Hungarian croplands. Since growing season of corn (June–August) is highly exposed, the fluctuation of corn yields showed a close linear relation to drought indices in three out four technological periods and in the three 30-year long periods (e.g. between 1981 and 2010 R²=0.78; y = -0.4657x + 8,3674; 30 couples).

The most conspicuous phenomenon is that more extrems happened in the last two decades than in the former seven decades. The variability of the climatic variability on the crop yields has been more and more apparent in the regression coefficients. It is partly for this reason that the average yields of the most drought-prone counties that lies in the GHP and covered the majority of former floodplains fall below the national average. Such a high level of exposure to drought fundamentally queries the economic rationale of cropland farming, led to the abandonment of vast areas of cropland and justifies the objective of the European Union to reduce EU’s share in global greenhouse gas emissions by 20%.

The yield losses as a result of droughts indicate a major transformation in the examined 90 years, the yield losses of five out of seven crops indicate a significant and close relation to pDAI values. These results indicate a major transformation in the meteorological conditions of cropland farming. Over the last one and a half decades extreme droughts and inundations have alternated rapidly. Corn deserves a special attention for several reasons. Besides wheat, it is corn that has the most extensive harvest area in Hungary. In the past decade it covered some 26–28% of Hungarian croplands. Since growing season of corn (June–August) is highly exposed, the fluctuation of corn yields showed a close linear relation to drought indices in three out four technological periods and in the three 30-year long periods (e.g. between 1981 and 2010 R²=0.78; y = -0.4657x + 8,3674; 30 couples).

The most conspicuous phenomenon is that more extrems happened in the last two decades than in the former seven decades. The variability of the climatic variability on the crop yields has been more and more apparent in the regression coefficients. It is partly for this reason that the average yields of the most drought-prone counties that lies in the GHP and covered the majority of former floodplains fall below the national average. Such a high level of exposure to drought fundamentally queries the economic rationale of cropland farming, led to the abandonment of vast areas of cropland and justifies the objective of the European Water Framework Directive that is the water retention in the former floodplains of the Great Hungarian Plain.

Carbon emission from land-use change is substantially enhanced by agricultural management

TAM. Pugh (1) ; A. Arvanitis (1) ; A. Olin (2) ; A. Ahlström (2) ; A. Arvanitis (1) ; A. Bayer (1) ; G. Klein (3) ; M. Lindeskog (2) ; G. Schurgers (4) ; A. Alshtröm (2) ; K. Kleist (3) ; M. Lindeskog (2) ; G. Schurgers (4)

(1) Karlsruhe Institute of Technology, IMK-IFU, Garmsch-Partenkirchen, Germany; (2) Lund University, Lund, Sweden; (3) FBL Netherlands Environmental Assessment Agency, Bilthoven, Netherlands; (4) University of Copenhagen, Department of geosciences and natural resource management, Copenhagen, Denmark

It is over three decades since a large terrestrial carbon sink was first reported. The magnitude of the net sink is relatively well known, and its importance for damping atmospheric CO2 accumulation, and hence climate change, widely recognised. But the contributions of underlying processes are not well defined, particularly the role of emissions from land–use change (ELUC) versus the terrestrial (TL) sink. An improvement of appropriate global-scale observations, process-based terrestrial biosphere models can facilitate understanding of present–day carbon cycling, whilst also underpinning climate projections in Earth System Models (ESMs). Yet representations of many fundamental processes in these models are neglected or immature, especially regarding land management. Here we quantify the effect of representative agricultural land management in a Global Vegetation Model. Accounting for harvest, grazing and tillage resulted in cumulative ELUC since 1950 ca. 70% larger than in simulations ignoring these processes. The vast majority of ESMs in the recent IPCC Fifth Assessment Report omit these processes, suggesting an overestimation in their terrestrial carbon sink, or an underestimation of SL, of up to 1.0 Pg C a–1. Management processes influencing crop productivity per se are important for food supply, but had little influence on ELUC.
Land-use/cover changes in the Uttarakhand Himalaya: assessment and mapping

VP. Satli (1)
(1) Mizoram University, Aizawl, Geography and Resource Management, Aizawl, Mizoram, India

Land is a dynamic and complex combination of factors – geology, topography, hydrology, soils, microclimate and communities of plants and animals. Land-use stands for the pattern of man’s activity on a piece of land for economic functions. Land-use/cover changes are of utmost importance to the human and ecological system. This paper aims to assess the land-use/cover changes in the Uttarakhand Himalaya. It also examines the factors affecting land-use/cover changes. Both qualitative and quantitative approaches were used for conducting this study. Data were obtained from the primary and secondary sources. A case study of 12 villages (Khandh Cad sub-watershed) was carried out and a household level survey was conducted on land-use/cover changes. Secondary data were gathered from the government records i.e. State Economic and Statistical Directorate, Dehradun. Land-use data from 1980 to 2009 were gathered and land cover changes were assessed through using various statistical methods and mapping. Participatory research appraisal was used to elucidate data through rapid field visit of the region. Farmers, extension workers and officials of various departments related to agriculture, horticulture and forest were interviewed to know the present trend of land-use/cover change. Five categories such as (1) forestland, uncultivable land comprises; area under non-agriculture and waste land, other uncultivable land comprises; cultivable waste, pasture, and land under nurseries, orchards, trees and bushes; (2) agriculture land comprises; area under cereal crops, non-cereal crops, cash crops, vegetables, and area under non-agriculture and waste land; other uncultivable land comprises; cultivable waste, pasture, and land under nurseries, orchards, trees and bushes; (3) land comprises; area under non-agriculture and waste land, other uncultivable land comprises; cultivable waste, pasture, and land under nurseries, orchards, trees and bushes; (4) land comprises; area under non-agriculture and waste land, other uncultivable land comprises; cultivable waste, pasture, and land under nurseries, orchards, trees and bushes; (5) uncultivable land comprises; area under non-agriculture and waste land, other uncultivable land comprises; cultivable waste, pasture, and land under nurseries, orchards, trees and bushes; (6) area under paddy comprised; area under paddy, wheat and cash crops, as the case study shows. Climate change impact on forest and cropping pattern was noticed. Within forest land-use, area under pine forest was observed increased up to 10% and oak forest cover decreased subsequently. This was occurred mainly due to warming of valleys and mid-altitudes. Similarly, cropping pattern has largely been changed from cultivation of subsistence cereals to cultivation of paddy, wheat and cash crops, as the case study shows. The major driving forces of land-use/cover changes were illustrated. State’s conservation measures (Forest act of 1982), People’s participation (establishment of Van Panchayat) and Chipko movement were observed as the driving forces of increase in forestland. Change in food habits was also noticed. In the mid-altitudes and in the highlands, temperate forests – pine, oak and coniferous – constitute forest land-use. In the main land, the cultivable land comprises; area under non-agriculture and waste land, other uncultivable land comprises; cultivable waste, pasture, and land under nurseries, orchards, trees and bushes; area under paddy comprised; area under paddy, wheat and cash crops, as the case study shows. Five important deserts in the world, particularly in China, Mongolia, Africa and India are expanding at an alarming rate. The expansion of deserts implies lesser availability of land for agriculture and allied activities which provide food and livelihood security to millions of people across the world. The chief drivers of desertification include deforestation, over grazing, over cultivation, logging, pressure of population, industrialization and poor land use practices.

Planning Commission of India has identified 15 resource development regions in the country, also known as the Agro Climatic Zones. Among the various regions, the Western Dry Region covers nine districts of the state of Rajasthan. It is one of the most arid regions in the country, characterized by desert ecosystems which are affected by desertification and degradation of land. The major deserts in the world, particularly in China, Mongolia, Africa and India are expanding at an alarming rate. The expansion of deserts implies lesser availability of land for agriculture and allied activities which provide food and livelihood security to millions of people across the world. The chief drivers of desertification include deforestation, over grazing, over cultivation, logging, pressure of population, industrialization and poor land use practices.

Impacts of changes in land surface processes on the West African Monsoon variability: Results from the LUCID intercomparison project

S. Sy (1); B. Sultan (2); N. De Noblet-Ducoudré (3); AT. Gaye (4); N. Oussame (5); M. Wade, (6); F. Yohann (7)
(1) LPAOSF/LOCEAN, Dakar, Senegal; (2) IRD, LOCEAN, Paris, France; (3) Laboratoire des Sciences du Climat et de l’environnement, CEA - Varenna, France; (4) University Cheikh Anta Diop Dakar, Laboratory of atmospheric and ocean physics, Dakar, Senegal; (5) ANACIM, Dakar, Senegal; (6) Univ. Cheikh Anta Diop, LPAOSF, Dakar, Senegal; (7) KINOME, Paris, Paris, France

West Africa has been highlighted as a hot spot of land surface-atmosphere interactions. The effect of changes in land surface processes on West African Monsoon (WAM) variability have been found very important. In this study, we analyze the outputs of the project Land-Use and Climate, Identification of Robust Impacts (LUCID) over West Africa. LUCID uses seventeen land-atmosphere models with common experimental configurations to explain the strong and constant impact of the land-use and land cover change (LULCC) between the preindustrial period and present day. Focusing our analysis on Sahel and Guinea zone where the changes in the extent covered of crops and pastures between 1870 and 1992 exceeds 5%. These studies have analyzed the performances of the individual GCMs/LSMs model involved in LUCID to simulate the WAM interannual variability. The results showed that the magnitude of these variability varies significantly from model to model resulting two major ‘features’ varying from one model to another: the land–atmosphere response function, and the simulated sensitivity to LULCC. Changes in land surface properties in each individual model depend on how these represent and respond to a land-cover perturbation have been shown, as well as their simulated impacts on fluxes, rainfall, and surface temperature. Finally, the climatic impacts of LULCC to those resulting from the changes in sea surface temperatures, sea ice extent, and increased greenhouse gas concentration (WAM) were either similar or opposite to the effect of variables (available energy, temperature, available water etc...), the amplitude of the impact of LULCC is similar to the impact of increased greenhouse gases and warmer oceans, but with opposite sign.
more than 80 percent of the irrigation and in some districts even up to 100 percent of the irrigation is done by wells and tube wells. This has important implication from the view point of desertification and sustainable agricultural practices considering the already low levels of ground water in desert regions. The forest cover in these nine districts is showing a declining trend owing to the land being diverted to cultivation. Besides forests, the area under other land uses is also being diverted to cultivation. The implication of this situation on the livelihoods and extent of poverty of the people in these districts. This in turn has implications on the health and other human development indicators. In this paper, the author has used Markov Chain analysis to see the direction of change in the land use pattern in the districts covered under the Western Dry Region. It was observed that among the various land use patterns, there was a high probability of land being converted to non-desertification as all the nine districts covered under the Western Dry Region of Rajasthan are already very low in terms of forests and further forest cover conversion to desertification could have serious implications in terms of desertification as all the nine districts covered under the Western Dry Region of Rajasthan are already very low in terms of forests and further forest cover conversion to desertification could have serious implications in terms of desertification. The districts were then ranked on the basis of both the indices and it was observed that there was no correlation between development and desertification. This leads to a very important finding in terms of development indicators were incidentally the districts having worst desertification indicators. A negative correlation was observed between development and desertification. This suggests a very important question that is development being done at a cost? In light of the various findings of this study the author has also suggested policy prescriptions for arresting desertification in the Thar Desert Region of Rajasthan.

P-2217-30

The Morphology of Urban Risk to Flooding In Metro-Manila, Philippines: Patterns of Exposure and Vulnerability Based on Informaton and Land Use/ Cover Change

MCT. Vicente (1); GT. Narisma (2); FP. Siringan (3); MAY. Loyzaga, (4); CFP. Del (1); PG. Sanchez (1); E. Gozo (2); JEG. Perez (3); RS. Dayawan (1)

The Project, “International Research Initiative on Adaptation to Climate Change–Coastal Cities at Risk (IRIACC–CCAR): Building Adaptive Capacity for Managing Climate Change in Coastal Megacities” is on-going from 2011–2016. Canada’s International Research Initiative on Climate Change Research Centre (IRIDC) manages IRIACC–CCAR in collaboration with three main research granting bodies, known as the Tri–Council: The Natural Sciences and Engineering Research Council (NSERC), the Social Sciences and Humanities Research Council (SSHRC), the Natural Sciences and Engineering Research Council of Canada (NSERC) and the Canadian Institutes of Health Research (CIHR). Under this transdisciplinary IRIACC–CCAR Project, Metro–Manila is a study site, along with six other coastal cities in the world. A component of this research for Metro–Manila, undertaken by the Manila Observatory with local partners and described below, is the study on the morphology of urban risk to flooding, which applies multi-temporal and multi-resolution remote sensing and geographic information systems (RS–GIS).

The specific objectives of this study are to: (1) Generate historical and updated locations of urban poor settlements, (2) Identify the spatial and temporal characteristics of the said settlements in relation to other land use/ cover and infrastructure, the former especially considering rural–urban and changing industrial and commercial activities as well as vegetation, (3) Describe the patterns of urbanization and physical development, such as by the emergence, growth, spread and even the disappearance of the said human settlements, (4) Study the factors contributing to flood risk, which then need to be addressed. Part I of the research gives the context of informality and vulnerability to flooding in terms of general land use/ cover change from 1972–2009 (LANDSATs courtesy of NASA). Part II involves change detection of informal settlements, that is, in 1997 and 2000 (SPOT courtesy of NAMRIA) as well as 2010 (ALOS AVNIR and PRISMS courtesy of JAXA). Part III then concerns overlaying thematic layers of flood risk, where River is Layer. Exposure and vulnerability to flooding were evaluated using two indices, UNDP (2004 and UNDRR 1979). In terms of hazard, this flood risk is especially attributed to low elevation coastal zones or LECZs, which are continuous areas along shores that are equidistant from high tidal levels (masl) and, as such, are prone to inundation (McGranahan, G., Balk, D. and Anderson, B. April 2007). Moreover and as a reflection of poor drainage, river choke points were also observed and validated (Siringan, F. and Perez, J.E., on–going research).

Resulting maps show an overall increasing trend in expansion or growth and distribution or spread of the informal settlements. These are found in marginal, hazard–prone and compromising locations, such as coasts, riverbanks and landslips but near advantageous sites like major roads as industrial and commercial zones. Also, the 1997 and 2000 clustering of informal settlements around socioeconomic attractors seem to give way to more movements towards the fringes of the metropolis in 2010. Dense and overcrowded formal and informal communities (“mixed” settlements), showing comparatively less signs of structural degradation, initially emerged and then declined. This appears closely associated with higher land tenure, which need to be studied more deeply. Very high resolution (VHR) satellite imageries are then necessary to monitor informal housing and livelihood, given their dispersion, as such conventional mapping tools as well as relatively small and degraded structural units. Besides poor drainage, factors contributing to flooding are: Haphazard urban expansion, densification, industrialization and commercialization, which have led to the loss of water bodies, vegetation and ground water. The study also show the need for detailed land use/ cover across time may also benefit from hyperspectral satellite imageries. Salient patterns of exposure and vulnerability to flooding then form evidence-based decision-support tools. This would lead towards better planning for preparedness and resilience, as by co–beneficial climate change adaptation as well as risk reduction and management (CCA–DWRM).

P-2217-31

The Changes of Crop Distribution and its Water Balance Effects in the West Liaohe River basin, China

Y. Yang (1); L. Yang (1)

(1) Institute of Geographic Sciences and Natural Resources Research, CAS, Beijing, China

As one of the origins of dry farming in North China, West Liaohe River Basin is located in the districts with high production of maize, which is the main producing area in China and the important commodity grain base. As a sensitive area of global change, West Liaohe River basin is situated in the eastern seaboard of China near the edge of the western of Northeast Plain, which showed an obvious warming trend and frequent drought in the recent years. Due to the increase of population, water resources development and utilization activities is increased, and the land desertification, vegetation degradation problems are becoming serious by the interaction of human activity and climate change. This study taking the West Liaohe River basin as a case study area, analyzing of the crops distribution changes in different climate conditions, and the land desertification, vegetation degradation problems are becoming serious by the interaction of human activity and climate change. This study taking the West Liaohe River basin as a case study area, analyzing of the crops distribution changes and spatial agglomeration situation in 2000, 2005 and 2010, using remote sensing tools and GIS technology. On this base, using the water balance model, quantitatively calculated the changes of water balance of the different crop types based on GIS technology and mathematical statistics in the West Liaohe River basin. And then we got the water balance effects of crop distribution variation from 2000 to 2010, and scenario simulated the water balance effects of crop layout changes in different climate conditions, by establishing the Remote Sensing–GIS coupled crop water balance model. The study indicates that, (1) Water resources pressure substantially reduced from 2000 to 2005, by 26.71 hundred million m3. And increased slowly from 2005 to 2010, by 5.50 hundred million m3. The actual irrigation increase 14.31 hundred million m3, accounting for 26.81% of available water in the West Liaohe River basin from 2000 to 2005, influenced by the main crops area increased substantially. And 0.88 hundred million m3 of the West Liaohe River basin from
2005 to 2010, influenced by the main crops area increased slowly. (3) The pressure of water resources was significantly in the West Liaohe River basin under different climatic conditions (normal year and dry year), the actual water demand for irrigation were respectively 12.94 hundred million m³ and 16.43 hundred million m³, there was serious contradiction between the water resources supply and demand. Adjusting crop planting structure, developing water-saving agriculture and improving the utilization efficiency of water resources would become the main route of agricultural sustainable development in the West Liaohe River basin.

This paper discusses the main obstacles to a sustainable charcoal value chain in sub-Saharan Africa and identifies key areas where interventions are required to improve sustainability while ensuring charcoal continues to provide livelihood benefits. It provides evidence of how a sustainable, transparent and properly regulated and governed charcoal sector could be part of the solution to energy access and economic challenges faced by many developing countries.

The paper summarises the most up-to-date literature on the issue at this time. Although the focus is on sub-Saharan Africa, some of the recommendations may be equally applicable to other charcoal-dependent developing countries.

Key recommendations

- Improve sustainability in the charcoal sector, and reduce associated degradation, through exploring community-based forest management options, gaining greater ownership and control over tenure and property rights, and implementing guidelines on sustainable harvesting and production.
- Improve governance across the charcoal value chain to create a regulated, transparent and coordinated sector which formally contributes to national economies.
- Invest in capacity development in improved kiln technologies, co-management of public or protected forests, agroforestry, woodlots, small-scale plantations, and financial management and reporting to improve sustainability and governance of the sector.
- Increase participation by disempowered stakeholders in the charcoal sector to encourage greater uptake of more efficient technologies and more sustainable management practices.

Transform the negative image of charcoal, allow national governments to earn charcoal revenues and tap into internationally recognized mechanisms to create incentives for investment in a sustainable charcoal sector.

**2218 - Land-based mitigation: agriculture, forests, bioenergy**

**ORAL PRESENTATIONS**

**K-2218-01**

**Emission and mitigation hotspots in the land use sector across the tropics**

M. Herold (1) ; M. Rufino (2) ; R.R. Roman Cuesta (1) ; L. Verchot (2) ; V. De Sy (3) ; S. Carter (1) ; A. Valero (1) ; C. Martius (2)

(1) Wageningen University, Wageningen, Netherlands; (2) Center for International Forestry Research (CIFOR), Bogor, Indonesia; (3) World Bank, Washington DC.

Deforestation is the largest net source of GHG emissions in the tropics, and mitigation initiatives such as REDD+ should consider agriculture as it is a key driver of deforestation. Climate-smart agriculture (CSA), so far an agriculture technologies focused exercise, can potentially reduce deforestation as the underlying assumption is that higher yields take pressure off forests. However, this cannot be taken for granted and deserves a closer look from science, policy and investment perspectives. If implemented in the right way, CSA has the potential for win-win outcomes as CSA aims to achieve both mitigation and adaptation goals. This also fits the recent focus in climate debates on agriculture as a driver of deforestation and ecosystem degradation, and becomes an integral part of the solution to saving the world’s forests.

In this session, we present new scientific findings on how agriculture and REDD+ are linked, how these are addressed in country strategies, and how an integrated perspective can exploit synergies and address conflicts. New data showing where and how much agriculture is driving deforestation, and the potential emissions reductions from reducing this driver will be discussed. We present a new tropical analysis on the contribution to GHG emissions from the AFOLU sector that offers a spatially explicit view of where the AFOLU hotspots of emissions are located and what is the relative contribution of forests vs non-forests we also analyze the potential to achieve mitigation through CSA. Presentations will be short to allow for a moderated discussion. The presentation and related discussions aim to stimulate an interactive debate around the possible linkages between REDD+ and CSA - both in policy and practice. The results can feed into ongoing discussions and ideas of a broader “land use agreement” incorporating both REDD+ and agriculture that is still high on the UNFCCC agenda. With the new data and results generated by several research partners, we are able to underpin the discussions with better understanding and bring critical issues to the forefront, such as: where and how can land-based mitigation through CSA be successful in reducing GHG emissions?

**K-2218-02**

**Developing a sustainable charcoal sector in Africa**

H. Neufeldt (1); P. Dobie (1); M. Iyama (1); K. Sander, (2)

(1) ICRAF, Nairobi, Kenya; (2) World Bank, Washington DC, United States of America

Charcoal is a vital source of energy for millions of people around the globe and one of the most commercialized resources in sub-Saharan Africa, yet policies to effectively govern the charcoal sector are lacking in many countries. Authorities in countries around the world tend to view charcoal production and use as an environmental and health problem. However, if managed properly charcoal provides a low-cost and locally available energy source that has the potential to become sustainable and contribute significantly to poverty alleviation.

**ORACLE: Opportunities and Risks of Agro-systems & forests in response to CLimate, socio-economic and policy changEs in France**

N. De Noblet-Ducoudré (1); I. Garcia De Cortazar-Atauri (2); JD. Bontemps (3); JC. Calvet (4); D. Carrer (5); J. Caubel (1); P. Delacote (6); PA. Jayet (7); N. Laanaia (1); L. Antonello (8); D. Loustau (9); A. Lungarska (7); S. Wieruszeski (1)

(1) Laboratoire des Sciences du Climat et de l’environnement, CEA-CNRS-UVSQ, Gif-sur-Yvette cédex, France; (2) INRA, Agroclim, Avignon, France; (3) AgroParisTech, Leflo, Nancy, France; (4) Meteo–France, CNRM, Toulouse, France; (5) Meteo France, CNRM–GAME, Toulouse, France; (6) INRA, Economics, Nancy, France; (7) INRA, Economie publique, Thiverval–Grignon, France; (8) AgroParisTech, Laboratoire d’économie forestière, Nancy, France; (9) INRA, ISPA, Villeneuve d’Ornon, France

Our rapidly changing climate significantly affects production of agricultural and forestry products throughout the world, with potential impacts on land-use practices and land-cover changes. In parallel, socio-economic decisions and environmental policies are evolving as agriculture and forestry are called to play a major role in the cost-effective climate mitigation portfolio. The Common Agricultural Policy for example is moving towards “de-coupling” and “greener” schemes, with increased concern for the environment. There is also growing pressure on scarce resources and increasing competition over soils for the production of food, feed, wood, energy and a broad range
ABSTRACT BOOK
GHG emissions in agricultural production processes will yet well understood where to set priorities for mitigation climate change mitigation strategies are scant. It is not development pathways that form part and result from sought to identify the required contribution of the sector strategy for climate change mitigation. Studies have integral part of any global low emissions development forestry, and land use sector (AFOLU) has to be an of biomass for bioenergy production, and potential associated abatement potential, its role as a source anthropogenic greenhouse gas (GHG) emissions and associated abatement potential, its role as a source of biomass for bioenergy production, and potential for sequestration from afforestation, the agricultural, forestry, and land use sector (AFOLU) has to be an integral part of any global low emissions development sought to identify the required contribution of the sector to long-term climate stabilization and have evaluated its technical and economical mitigation potential. Detailed yet comprehensive GHG emission analysis for five development pathways that form part and result from climate change mitigation strategies are scant. It is not yet well understood where to set priorities for mitigation efforts, both geographically and sectorially. It is further not clear which role specific technologies aimed at reducing GHG emissions in agricultural production processes will have to play.

Applying the IIASA integrated assessment modelling framework with the Global Biosphere Management Model (GLOBIOM) used for the AFOLU sector we create mitigation scenarios to reduce emissions to levels consistent with attaining a 2-degree climate target. The analysis is carried out for three shared socio-economic development pathways (SSP) up to the year 2050. A basic set of model simulations is carried out with the existing set of agricultural technologies to create standard mitigation cases for each SSP. An extended set of simulations implements additional assumptions on add-on technologies for mitigation in agricultural production processes.

The extent of agricultural mitigation to limit emissions to levels consistent with a two-degree target is 2.1 GtCO2eq yr⁻¹, 3.3 GtCO2eq yr⁻¹, and 3.7 GtCO2eq yr⁻¹ under SSP1, SSP2, and SSP3, respectively. Abatement of emissions from land use change (LUC) consistently accounts for around 80% of the total. Mitigation potentials of CH4 and N2O from agriculture production are around 11% to 14% and 7%, respectively.

An assessment of priorities for AFOLU mitigation highlights the fundamental role that developing and emerging economies will have to play. Mitigation efforts should be prioritized to regions with the highest economic abatement potentials at emissions price levels consistent with the two-degree target, namely Brazil and the rest of South America, the Congo Basin and Western Africa, Southern Africa, and China. Within those regions and regional emissions patterns and the resulting abatement potentials, either a focus on the reduction of LUC CO2 or on emissions from agricultural production should be prioritized. In the regions with large agricultural systems, regional emissions patterns and the potential for risks or benefits (smith et al. 2013). Sparrow leads to an important trade-off in the second half of the century.

...
Agroecological practices adopted by Malagasy farmers to reduce farms carbon footprint in the Central (Itasy) and East Coast (Anilanjirofo) of Madagascar

N. Rakotovao (1); J. Razakararitrimo (1); T. Mambo (2); S. Rakotomampianina (3); M. Jahiel (4); A. Albrecht (5); S. Bernoux (6)

(1) University of Antananarivo, Laboratoire des Radiosotopes, Antananarivo, Madagascar; (2) University of Antananarivo, Laboratoire des Radiosotopes, Antananarivo, Madagascar; (3) Agrisud International, Antananarivo, Madagascar; (4) Université libre de Bruxelles, Brussels, Belgium; (5) Institut de Recherche pour le Développement, Umr eco&sols, Montpellier, France; (6) University of Antananarivo, Laboratoire des Radioisotopes, Antananarivo, Madagascar; (7) Agrisud International, Antananarivo, Madagascar; (8) Institut de Recherche pour le Développement, Umr eco&sols, Montpellier, France; (9) CNRS, Umr system, Montpellier, France; (10) University of Antananarivo, Laboratoire des Radioisotopes, Antananarivo, Madagascar; (11) Institut de Recherche pour le Développement, Umr eco&sols, Montpellier, France; (12) University of Antananarivo, Laboratoire des Radioisotopes, Antananarivo, Madagascar; (13) Institut de Recherche pour le Développement, Umr eco&sols, Montpellier, France; (14) CNRS, Umr system, Montpellier, France

For decades, Malagasy farmers have dealt with the low performance of the agricultural system and cope with the threat of food insecurity. This low productivity is caused by various factors including lack of means of production, and degradation of natural resources such as loss of soil fertility. In addition, the effects of climate variability constrained farmers to shift constantly cropping calendars. Therefore, agroecology was proposed to farmers on one hand to cope with food insecurity by increasing agricultural production and diversifying crops in order to get more sources of incomes and on another hand to restore the production environment. Marshed rice cultivation and to contribute to climate change adaptation. First, this work aimed to estimate the carbon footprint of farms in two regions located in the Central and the East Coast of Madagascar. Secondly, the contribution of each farm to climate change mitigation, the agroecological practices adopted by farmers to carbon footprint at farm scale was assessed. The annual flux of the three main greenhouse gases encountered in the agricultural context, carbon dioxide (CO2), methane (CH4) and the nitrous oxide (N2O) expressed in CO2 equivalent is considered as the carbon footprint of each farm. Twenty smallholder farms selected from farm typologies per region were studied; twelve farms located in the Central Highlands and eight at the East Coast. Farms located in the central region were characterized by intensification of annual cropping systems using agroecological practices such as intensified rice system which alternates flooding and drying of rice fields, composting organic residues and planting fruit trees in association with annual cropping systems. Agricultural activities of farms located in the East Coast were based on clove plantation associated with annual crops either in simple specie agroforestry or mixed tree species agroforestry and the traditional twice-a-year rice cropping system. Farm resource flow maps were developed in order to represent all the structures and characteristics of each farm. GHG-source and GHG sink compartments' inventory was carried out and emission factors adapted to each zone were selected from the literature. A local-specific farm carbon footprint calculator was developed. The results showed that farm carbon footprint average amounted to 3.04 Mg CO2eq ha⁻¹ y⁻¹ in the central and in the east coast respectively. Farms in the East Coast showed high carbon footprint because of the traditional twice-a-year rice cropping. In the Central Highlands, the intensified rice cropping system reduced the farm carbon footprint by reducing methane emission, composting organic residues reduces also farm carbon footprint up to 30% by improving carbon sequestration in the soil. The Carbon calculator allowed a farm carbon footprint reduction between 15 to 51% due to carbon storage in woody biomass. These results showed another aspect of the beneficial impacts of agroecological practices when adopted by smallholder farmers in Madagascar, at farm scale, to climate change mitigation.
P-2218-02

The contribution of agroforestry systems for climate change mitigation - A systematic analysis
D. Feliciano (1); D. Nayak, (1); P. Smith (2); E. Wollenberg, (3); H. Neufeldt (4); J. Hillier, (1)
(1) Institute of Biological and Environmental Sciences, School of Biological Sciences, Aberdeen, United Kingdom;
(2) University of Aberdeen, Institute of Biological & Environmental Sciences, Aberdeen, United Kingdom;
(3) Gund Institute for Ecological Economics, School of environment and natural resources, Vermont, United States of America; (4) ICAF, Nairobi, Kenya

Climate change mitigation and food security are two of the most pressing challenges of human society. Agroforestry systems, defined as a mixture of trees on external and internal boundaries, cropland, homestead plots or on any other available niche of farmland, can provide both climate change mitigation and food. There are several types of agroforestry systems with different rates of above ground and soil carbon (C) sequestration. The amount of carbon sequestered will depend on the type of system, climate and region. We undertook a meta-analysis that included data collection from several studies on carbon sequestration for different agroforestry systems, climates and regions in the world. The objective was to provide information on characteristics of agroforestry systems, some of which need to be addressed in future studies if the implementation of forest based CDM project in Africa. The study was a desk review and focused group discussions during training workshops on rapid forest stock appraisal (RASCA) for academia, research staff from relevant government ministries, extension services and civil society organisations. The data collected was analyzed using qualitative research approaches where key themes and frames were generated. Quantitative data was analyzed using appropriate statistical procedures. It was evident from the UNFCCC database, since 2004 to 2016, only 2% of all registered CDM projects were from Africa, as compared to 84% from Asia and Pacific Ocean, 13% from Latin America and Caribbean and 1% from Economies in Transition. Of the 2% from Africa, a very negligible percentage was from biomass as compared to hydro, wind and other GHG gases. This demonstrated very limited number of CDM projects that could have significantly wide scale on investment, improved economy and mitigation of GHG emissions from land based sector.

The major identified limiting factors on low uptake of CDM forest based and other related projects were: complicated processes on developing CDM projects especially on how to initiate project idea note (PIN) and develop project design document (PDD). This was compounded with inadequate capacity from Africa especially on the methodology resulting from hiring international experts to support local communities and African governments to develop and implement CDM projects. The stringent rules on implementation of Kyoto Protocol on forest based and other related projects also played a significant role. For instance, CDM reforestation activities as per the Kyoto Protocol was to take place if there has been no forest since 31st Dec. 1989 or afforestation activities if there has been no forest for atleast 50 years. These periods specified, most of the African areas were forested. Also a number of African countries have not agreed on clear definition of forest to enable implementation of forest based CDM project. The other limiting factor is political instability and war among African states that continuously scared investors. This hindered formulation of forest based policies that will capitalize on emergent payment of ecosystem services. These factors among others constitute lost opportunities during the first commitment period of Kyoto protocol for African countries. Enhanced capacity among forestry stakeholders, formulation of favourable policies and continuous update of Kyoto Protocol to suit emerging circumstances in the African continent will be critical on accelerating the validation, registration and implementation of forest based CDM project in Africa.

P-2218-04

Limiting factors on low uptake of Clean Development Mechanism based projects in Africa: Lost opportunities during first commitment period of Kyoto Protocol
L. Mahamane (1)
(1) African Forest Forum (AFF), Nairobi, Kenya

Africa countries like other developing countries in the rest of the world signed and ratified the Kyoto Protocol in order to benefit from the clean development mechanism (CDM) funds aimed at mitigating greenhouse gas emission from land used based activities. A study was conducted in 10 African countries aiming to identify the main limiting factors on low uptake of CDM forest based projects in Africa. The study was a desk review and focused group discussions during training workshops on rapid forest stock appraisal (RASCA) for academia, research staff from relevant government ministries, extension services and civil society organisations. The data collected was analyzed using qualitative research approaches where key themes and frames were generated. Quantitative data was analyzed using appropriate statistical procedures. It was evident from the UNFCCC database, since 2004 to 2016, only 2% of all registered CDM projects were from Africa, as compared to 84% from Asia and Pacific Ocean, 13% from Latin America and Caribbean and 1% from Economies in Transition. Of the 2% from Africa, a very negligible percentage was from biomass as compared to hydro, wind and other GHG gases. This demonstrated very limited number of CDM projects that could have significantly wide scale on investment, improved economy and mitigation of GHG emissions from land based sector.

The major identified limiting factors on low uptake of CDM forest based and other related projects were: complicated processes on developing CDM projects especially on how to initiate project idea note (PIN) and develop project design document (PDD). This was compounded with inadequate capacity from Africa especially on the methodology resulting from hiring international experts to support local communities and African governments to develop and implement CDM projects. The stringent rules on implementation of Kyoto Protocol on forest based and other related projects also played a significant role. For instance, CDM reforestation activities as per the Kyoto Protocol was to take place if there has been no forest since 31st Dec. 1989 or afforestation activities if there has been no forest for atleast 50 years. These periods specified, most of the African areas were forested. Also a number of African countries have not agreed on clear definition of forest to enable implementation of forest based CDM project. The other limiting factor is political instability and war among African states that continuously scared investors. This hindered formulation of forest based policies that will capitalize on emergent payment of ecosystem services. These factors among others constitute lost opportunities during the first commitment period of Kyoto protocol for African countries. Enhanced capacity among forestry stakeholders, formulation of favourable policies and continuous update of Kyoto Protocol to suit emerging circumstances in the African continent will be critical on accelerating the validation, registration and implementation of forest based CDM project in Africa.

P-2218-03

Development of a global level decision support tool to reduce agricultural emissions
D. Feliciano (1); D. Nayak, (1); S. Vetter, (1); J. Hillier, (1)
(1) Institute of Biological and Environmental Sciences, School of Biological Sciences, Aberdeen, United Kingdom

The tool described is an Excel-based tool which brings together several empirical models to estimate greenhouse gas emissions (GHG) in rice, cropland and livestock systems, and to provide information about the most effective mitigation options. Greenhouse gas emissions are estimated in terms of total GHG emitted in kg of carbon dioxide equivalent per hectare (kg CO2eq ha-1) and in terms of GHG intensity, i.e. total of carbon dioxide equivalent (CO2eq kg-1). This tool allows for management-relevant GHG assessments to be made with relatively little effort. Management practices are chosen by the user and mitigation options are estimated and ranked according to its mitigation potential. The aim of the tool is to accommodate a range of users from an introductory to advanced level, depending on objectives and level of existing knowledge, or data available. This paper describes the methods used to develop a tool to enable policy makers to explore the most appropriate GHG mitigation options available for any region worldwide. Since the target users are policy-makers and policy advisers, this tool was built to be user-friendly, and not time consuming. Apart from these characteristics, the tool differs from other tools available because it provides information about options that are not always taken into consideration, or any other available niche of farmland, can provide both climate change mitigation and food. There are several types of agroforestry systems with different rates of above ground and soil carbon (C) sequestration. The amount of carbon sequestered will depend on the type of system, climate and region. We undertook a meta-analysis that included data collection from several studies on carbon sequestration for different agroforestry systems, climates and regions in the world. The objective was to provide information on characteristics of agroforestry systems, some of which need to be addressed in future studies if the implementation of forest based CDM project in Africa. The study was a desk review and focused group discussions during training workshops on rapid forest stock appraisal (RASCA) for academia, research staff from relevant government ministries, extension services and civil society organisations. The data collected was analyzed using qualitative research approaches where key themes and frames were generated. Quantitative data was analyzed using appropriate statistical procedures. It was evident from the UNFCCC database, since 2004 to 2016, only 2% of all registered CDM projects were from Africa, as compared to 84% from Asia and Pacific Ocean, 13% from Latin America and Caribbean and 1% from Economies in Transition. Of the 2% from Africa, a very negligible percentage was from biomass as compared to hydro, wind and other GHG gases. This demonstrated very limited number of CDM projects that could have significantly wide scale on investment, improved economy and mitigation of GHG emissions from land based sector.

The major identified limiting factors on low uptake of CDM forest based and other related projects were: complicated processes on developing CDM projects especially on how to initiate project idea note (PIN) and develop project design document (PDD). This was compounded with inadequate capacity from Africa especially on the methodology resulting from hiring international experts to support local communities and African governments to develop and implement CDM projects. The stringent rules on implementation of Kyoto Protocol on forest based and other related projects also played a significant role. For instance, CDM reforestation activities as per the Kyoto Protocol was to take place if there has been no forest since 31st Dec. 1989 or afforestation activities if there has been no forest for atleast 50 years. These periods specified, most of the African areas were forested. Also a number of African countries have not agreed on clear definition of forest to enable implementation of forest based CDM project. The other limiting factor is political instability and war among African states that continuously scared investors. This hindered formulation of forest based policies that will capitalize on emergent payment of ecosystem services. These factors among others constitute lost opportunities during the first commitment period of Kyoto protocol for African countries. Enhanced capacity among forestry stakeholders, formulation of favourable policies and continuous update of Kyoto Protocol to suit emerging circumstances in the African continent will be critical on accelerating the validation, registration and implementation of forest based CDM project in Africa.

P-2218-05

Options for reducing greenhouse gas emissions from the agricultural sector: abatement potential and cost of technical measures
S. Pellerin (1); L. Bamiere (2); D. Angers (3); F. Béline (4); S. Recous (1); L. Bamiere (2); D. Angers (3); F. Béline (4); S. Recous (1)
(1) INRA, Environment and Agronomy, Villenave d’ornon, France; (2) INRA, Umr smart, agronomie, thiverval-Grignon, France; (3) INRA, Umr smart, agronomie, thiverval-Grignon, France; (4) IRSTEA, U ure, Rennes, France; (5) INRA, Umr herborives, Saint Genes Champelanne, France; (6) Agroparistech, Umr iees, Paris, France; (7) INRA, Umr Thiverval-Grignon, France; (8) INRA, Umr smart, thiverval-Grignon, France; (9) INRA, Umr Thiverval-Grignon, France; (10) INRA, Umr Thiverval-Grignon, France; (11) INRA, Umr Thiverval-Grignon, France; (12) INRA, Umr Thiverval-Grignon, France; (13) INRA, Umr Thiverval-Grignon, France; (14) INRA, Umr Thiverval-Grignon, France; (15) INRA, Umr Thiverval-Grignon, France; (16) INRA, Umr Thiverval-Grignon, France
In Europe, agriculture is responsible for 10.2% of greenhouse gas (GHG) emissions, with concomitant opportunities for mitigation efforts as greenhouse gas (GHG) abatement objectives via three levers: a reduction in N2O, CH4 and CO2 emissions, additional carbon storage in soil and biomass and energy production (substitution effect). The objective of this study is to assess technical measures to reduce GHG emissions at the farm level in a European context without reducing production outputs. France was chosen as a case study with a typical intensive and diversified agriculture.

Ten measures, split into 26 sub-measures, were selected from an initial list of 100 “candidate” measures. The selection process was based on five criteria: the expected effect on production, the GHG abatement potential, the current availability of the technology required to implement the measure and of validated scientific knowledge establishing its efficacy, the applicability of the measure, including its social acceptability, and the potential synergies or antagonisms with other agri-environmental objectives, including adaptation to climate change.

The ten selected measures were linked to 1) nitrogen management in the field (better adjust fertiliser application rates, introduce more legumes in arable crop rotations and temporary grassland), 2) increase carbon storage in soils and biomass (reduced tillage, cover crops and grass buffer strips, agroforestry and hedges, grassland management), 3) livestock diets (unsaturated fats or additives in diets, better adjust the amount of proteins), and 4) energy production and consumption on farms (methanisation and flares, energy savings). Their abatement potential and cost were accurately calculated and compared, using a marginal abatement cost curve approach (Moran et al., 2011).

Results showed that the overall abatement potential can be broken down into three groups. One third of the cumulated abatement potential corresponds to sub-measures with a negative technical cost. These sub-measures are based on an improved efficiency of inputs like N fertilizers, animal feed and energy, thus reducing GHG emissions and costs, with no negative effect on production (win–win measures). Moreover, these sub-measures have a positive expected effect on water and air quality and no antagonism exists with the objective of adaptation to climate change.

The second group corresponds to sub-measures with a moderate cost (E25 per metric ton of CO2 avoided). These sub-measures require specific investments (e.g. methanisation) or modifying the cropping system slightly (reduced tillage, legumes, agroforestry). However, their additional cost or low income is partially compensated for by a reduction in other costs (fuels) or additional marketable products (biogas, electricity, wood).

The third group corresponds to sub-measures with a high cost (E25 per metric ton of CO2 avoided). These sub-measures require investment with no direct financial return (flares), the purchase of specific inputs (nitrification inhibitors, unsaturated fats or additives incorporated into the diet of ruminants), dedicated labour time (cover crops, hedges) or involve greater production losses (grass buffer strips reducing the cultivated surface area for example).

When calculated under current national inventory rules, the overall annual abatement of all these measures represents 10% of annual emissions from agriculture. This percentage is increased when calculations are based on higher tier approaches.

It is concluded that cost-effective technical levers exist for agriculture to support greenhouse gas mitigation without hampering production and adaptation goals.

P-2218-06 Land Use Emissions Abatement and Consequences for Food Prices

M. Stevanovic (1) ; A. Popp (1) ; B. Bodirsky (1) ; F. Humpeñovici (1) ; M. Bonsch (1) ; D. Sanchez, (3) ; J. Dietrich (1) ; S. Rolinski (1) ; A. Biewald (1) ; X. Wang, (1) ; C. Müller (1) ; C. Müller (1) ; Potsdam Institute for Climate Impact Research, Potsdam, Germany

Considerable emission cuts of greenhouse gases (GHG) are required in order to prevent further warming of the planet and to reduce the risk of severe impacts attributed to climate change (Meinshausen et al., 2009, Nature 458: 1158–1162). The agricultural, forestry and other land use sector (AFOLU) is one of the central players in such mitigation efforts as greenhouse gas (GHG) abatement objectives via three levers: a reduction in N2O, CH4 and CO2 emissions, additional carbon storage in soil and biomass and energy production (substitution effect). The objective of this study is to assess technical measures to reduce GHG emissions at the farm level in a European context without reducing production outputs. France was chosen as a case study with a typical intensive and diversified agriculture.

Ten measures, split into 26 sub-measures, were selected from an initial list of 100 “candidate” measures. The selection process was based on five criteria: the expected effect on production, the GHG abatement potential, the current availability of the technology required to implement the measure and of validated scientific knowledge establishing its efficacy, the applicability of the measure, including its social acceptability, and the potential synergies or antagonisms with other agri-environmental objectives, including adaptation to climate change.

The ten selected measures were linked to 1) nitrogen management in the field (better adjust fertiliser application rates, introduce more legumes in arable crop rotations and temporary grassland), 2) increase carbon storage in soils and biomass (reduced tillage, cover crops and grass buffer strips, agroforestry and hedges, grassland management), 3) livestock diets (unsaturated fats or additives in diets, better adjust the amount of proteins), and 4) energy production and consumption on farms (methanisation and flares, energy savings). Their abatement potential and cost were accurately calculated and compared, using a marginal abatement cost curve approach (Moran et al., 2011).

Results showed that the overall abatement potential can be broken down into three groups. One third of the cumulated abatement potential corresponds to sub-measures with a negative technical cost. These sub-measures are based on an improved efficiency of inputs like N fertilizers, animal feed and energy, thus reducing GHG emissions and costs, with no negative effect on production (win–win measures). Moreover, these sub-measures have a positive expected effect on water and air quality and no antagonism exists with the objective of adaptation to climate change.

The second group corresponds to sub-measures with a moderate cost (E25 per metric ton of CO2 avoided). These sub-measures require specific investments (e.g. methanisation) or modifying the cropping system slightly (reduced tillage, legumes, agroforestry). However, their additional cost or low income is partially compensated for by a reduction in other costs (fuels) or additional marketable products (biogas, electricity, wood).

The third group corresponds to sub-measures with a high cost (E25 per metric ton of CO2 avoided). These sub-measures require investment with no direct financial return (flares), the purchase of specific inputs (nitrification inhibitors, unsaturated fats or additives incorporated into the diet of ruminants), dedicated labour time (cover crops, hedges) or involve greater production losses (grass buffer strips reducing the cultivated surface area for example).

When calculated under current national inventory rules, the overall annual abatement of all these measures represents 10% of annual emissions from agriculture. This percentage is increased when calculations are based on higher tier approaches.

It is concluded that cost-effective technical levers exist for agriculture to support greenhouse gas mitigation without hampering production and adaptation goals.

P-2218-07 Terrestrial carbon sinks: the critical role in deep greenhouse gas reduction scenarios and ecological limits to large scale carbon dioxide removal

MS. Torn (1) ; L. Smith (2) ; D. Sanchez, (3) ; JH. Williams, (4) ; A. Jones, (1)

(1) Lawrence Berkeley National Laboratory, Earth Sciences Division, Berkeley, CA, United States of America; (2) University of California Berkeley, Energy and Resources Group, Berkeley, CA, United States of America; (3) Berkeley, Energy and resources group, Berkeley, United States of America; (4) Energy and Environmental Economics (E3), San Francisco, United States of America

Pathways to achieving deep greenhouse (GHG) reductions (such as 80% reductions by 2050) have implications for carbon cycle science. This talk will highlight the critical role that terrestrial carbon management plays in reducing GHG emissions from the agriculture, energy and GHGs have in reading deep decarbonization goals.

In addition, many climate change mitigation scenarios include terrestrial atmospheric carbon dioxide removal (BCDR) or carbon neutral bioenergy production through bioenergy with carbon capture and storage (BECCS) or afforestation/reforestation. Very high sequestration potentials for these strategies have been reported, and...
we evaluate the potential ecological limits (e.g., land and resource requirements) to implementation at the 1 Pg C y⁻¹ scale relevant to climate change mitigation for U.S. and global scenarios. We estimate that removing 1 Pg C y⁻¹ via tropical afforestation would require at least 7×10⁶ ha of land, 0.09 Tg of 11 phosphorous, and would increase evapotranspiration from those lands by almost 50%. Because of improved carbon capture technologies, we are updating (and reducing) our understanding of the climate benefits for BECS: a previous estimate was 2×10⁸ ha land and 20 Tg y⁻¹ of nitrogen (20 % of global fertilizer nitrogen production). Miscanthus could meet the same biomass production with much lower N fertilizer requirements. Consequently, Miscanthus is thus imperative in order to identify potential land uses, water demand and supply, and energy production as well as significant potential benefits depending on implementation.

**P-2218-08**

An assessment of Brazilian biofuels expansion from a climate-resilient pathways framework

W. Wills (1); M. Obermaier (2); C. King, (3); A. Xavier (3); B. Scanlon (4); M. Moreira (5)

(1) Universidade Federal do Rio de Janeiro (UFRJ), Instituto Alberto luiz coimbra de pós-graduação e pesquisa de engenharia (COPPE), Rio de Janeiro, RJ, Brazil; (2) Universidade Federal do Rio Grande do Sul (UFRGS), Instituto Alberto Luis Coimbra de Pós-Graduação e Pesquisa de Engenharia (COPPE), Porto Alegre, RS, Brazil; (3) University of Texas – Austin, Bureau of Economic Geology, Austin, United States of America; (4) University of Texas – Austin, Energy Institute, Austin, United States of America; (5) Agroicone, São Paulo, Brazil

Climate change’s impact on society, health, and nature is a global challenge with local effects and needs for response. One of the utmost concerns about climate change is the potential impacts this can have on society, health, and nature. We have already experienced the effects of climate change, and we need to act now in order to prevent further impacts.

**P-2218-09**

Planetary limits to Bio-Energy Carbon Capture and Storage (BECCS) negative emissions

A. Wiltshire (1); T. Davies-Barnard (2); C. Jones (1); J. Lowe (3)

(1) Met Office, Hadley Centre, Exeter, United Kingdom; (2) University of Exeter, Exeter, United Kingdom; (3) Met Office, Lead scientist of avoid, Exeter, United Kingdom

Most but not all IPCC WG3 emission scenarios stabilizing climate at low levels, such as 1.5°C, require large scale deployment of Bio-Energy Carbon Capture and Storage (BECCS). BECCS allows for negative emissions, which is the artificial removal of carbon dioxide from the atmosphere (CDR). BECCS can therefore offset anthropogenic emissions, and even lead to overall net negative emissions. In this study we consider three alternative scenarios of BECCS deployment ranging from very large-scale deployment simultaneously securing large levels of land conversion to an extreme level of tropical land conversion to maximise yields. These scenarios are used in combination with simulations from the HadGEM2-ES earth system model to assess implications of climate change on yield and the emissions associated with deforestation, as well as the biophysical effect on climate associated with the land–use change. These are combined to assess the net climate effects of large-scale BECCS deployment. Overall, in our assessment we find the contribution of BECCS is unlikely to exceed cooling of 0.7 deg C by 2100. The median estimate of total negative emissions in the IPCC WG3 database compatible with the 2°C target is 166 GtC. The highest estimates presented here is 130GtC.

**P-2218-10**

Assessment of options for land use in a post-2020 world

P. Wylie (1); J. Funk, (2); J. Brana-Varela, (3)


Agricultural, forestry, and other land use (AFLU) account for nearly 25% of global GHG emissions while also absorbing a significant amount of emissions according to IPCC AR5. In this light, IUCN and a group of leading organizations focused on UNFCCC negotiations have been reaching out to Parties to discuss the role of land use by the research centers from Brazil and US) that integrates basin-scale water resources impact assessment, land–use change analysis, and energy–economy–wide modelling of socioeconomic and GHG impacts due to biofuels use. Our presentation will focus on exploring our methodological framework for CRP assessment and present first results obtained in the areas of water resources and land use management.
Expert workshops over the last 18 months in Bonn and Lima as well as the Global Landscapes Forum, advanced discussions and identified solutions for this important issue. All of those events included the REDD+-LUCCF, and agriculture negotiators, in order to ensure the discussion covered full scope of land use issues. These discussions highlighted risks to the integrity of a new climate regime if the role of the land sector is not adequately or appropriately reflected in the Paris agreement.

Taking stock of recent publications on the subject and the current status of land use, land-use change and forestry policies, REDD+, deforestation and forest degradation and related CDM discussions in the UNFCCC, the relative strengths and weaknesses of options for how the land sector might be addressed in a post-2020 ADP agreement, will be highlighted. This set of options will have been discussed at a targeted workshop the month before amongst ADP lead negotiators.

Based on recent research, key questions that need to be addressed will focus on:

- What specific attributes are needed in a framework to promote ambitious emission reductions from the land sector?
- Based on summaries of the INDC submissions to date and beyond, what are Parties to the UNFCCC already preparing domestically to recognize the importance of the land use into their post-2020 contributions?

Beyond global agreement in Paris at COP21, what can the international scientific community and both international & domestic organizations do to support permanence in any future gains on the emission gap via ambitious action within the land sector?

**2219 - Politics and numbers: Political and technical challenges in reducing emissions from forests with REDD+**

**K-2219-01**

**The REDD+ policy arena and the politics of numbers and information sharing**

M. Brockhaus (1); A. Angelsen (2); GM. Di (3)

(1) CIFOR, Bogor, Indonesia; (2) Norwegian University of Life Sciences, School of economics and business, As, Norway; (3) University of Leeds, Leeds, United Kingdom

Forests are an integral part of the international climate mitigation agenda. Transformational change beyond the forestry sector is required to realize the mitigation potential from avoided deforestation and forest degradation (REDD+). In the envisioned REDD+ architecture, payments will be made for carbon and non-carbon results, which need to be measured, reported of verified (MRV). Highly technical information needs to be translated into financial action. Information and information sharing are key features in REDD+ far beyond the MRV of carbon and co-benefits. In addition, dense webs of political actors and economic interests come to the forefront as countries become “ready for REDD+”.

Evidence-based policy design and formulation aims at devising policies based on rigorous and objective information (Petrosino et al. 2001). While a factual basis is crucial, decision making is inherently a political process, and the outcome of procedural and technical policy solutions are affected by power relation in the relevant policy arena. Multiple actors, both governmental and non-governmental, with their multiple interests, bargain and negotiate to formulate public policies, often in network structures formed around them. Such a process may not produce optimal outcomes (Peskett and Brockhaus 2009, Moog et al 2012 conference paper, Brockhaus and Angelsen 2012). National REDD+ policy processes are understood as negotiated at the Global Landscapes process, with politics and political economy aspects being critical for the outcomes. Effective, efficient and equitable (3E) outcomes are then constrained or enabled by the political conditions which are contextual to the specific country and REDD+ policy domain. To understand the constraints and opportunities in policy processes, design and implementation, we have to recognize the political nature on these processes.

This paper deals with a particular aspect of the politics of numbers in REDD+, namely how information, measures and data are produced and used to support specific views on what REDD+ should look like. In particular, we investigate: (1) what are existing procedures for information sharing, (2) who holds information and has to be consulted in REDD+ policy design and implementation, and (3) which institutional and actor-related factors enable or hamper evidence-driven definition, measurement and reporting as well as diffusion of numbers and information across the REDD+ policy arena.

We draw on the “4i” framework developed in Brockhaus and Angelsen (2012), and investigate how institutional stickiness, as well as actors’ ideas and interests interact with the fourth i in the REDD+ arena, information, and how this affects the potential for transformational change required to realise REDD+ outcomes. We present results from a global comparative research project (GCs) undertaken by the Center for International Forestry Research (CIFOR) since 2009 in 14 countries in Africa (Burkina Faso, Cameroon, DRC, Ethiopia, Mozambique, and Tanzania), Latin America (Brazil, Bolivia, and Peru), and Asia Pacific (Indonesia, Nepal, Laos, Papua New Guinea, and Vietnam). The comparative analysis is based among other elements on country-level analyses of the drivers of deforestation, and the institutional and political economy context in which REDD+ policies are being designed, a media based discourse analysis, a policy network analysis, and a content analysis of REDD+ policy documents. All these elements were designed for comparative analysis through the development of extensive guidelines (for an overview on methods and specific guidelines see Brockhaus and Di Gregorio 2012; Brockhaus et al 2012; Di Gregorio et al 2012).

Our findings indicate that despite the increasing levels of investments in countries’ MRV systems, as well as analysis, knowledge and early lessons from ongoing REDD+ policy processes, there is still limited understanding and in consequence, limited action for curtailting the impact of politics on numbers and information on effectiveness, efficiency and equity of a REDD+ mechanism, and what factors would enable and effective information sharing. In addition, our evidence indicates limited political will and interest in “getting the numbers right”, and that data insecurity and lack of clarity may serve then as a justification for inaction.

**K-2219-02**

**Politics of numbers in REDD+: the case of reference levels**

A. Angelsen (1); M. Brockhaus (2); HA. Teklay (1)

(1) Norwegian University of Life Sciences, School of economics and business, As, Norway; (2) CIFOR, Bogor, Indonesia

Designing and implementing REDD+ assumes quantification of past and current carbon emissions, constructing a counterfactual future scenario for emissions (i.e. the reference level – RL), as well as indicators for (change in) non–carbon benefits. Most REDD+ countries are characterized by a poor data foundation for undertaking such quantifications, resulting in high uncertainties. In addition, choices have to be made related to what exactly should be measured (including the definition of what constitute a “forest”), the approach to measuring the selected variables (e.g. scope, quality standards), and how the data should be independently verified.

This lack and uncertainty of relevant data creates a fertile ground for “gaming”, defined as the manipulation of data for own benefits. “Gaming” does not imply fabricating data (although that might happen too), but rather processes where the unavoidable choices in data generation are heavily influenced by self-interests. Different stakeholders
have different interests in what to be measured, the magnitude of the selected variables, and how the variables should be measured and verified. The most obvious example is how to set the RL in a result-based system: a high RL will give higher estimated emissions reductions and thereby higher payments to those assigned the rights to sell emissions reductions. Even without payments, the RL provides a benchmark for measuring the performance of projects and policies, with the credibility and reputation of REDD+, donors and governments being at stake. More generally, what is being measured shapes the political agenda and how different interests are being balanced in the political process. What is being counted counts.

We hypothesize that the degree and nature of gaming with numbers depends on both the underlying uncertainty, the extent and quality of the existing data base, the stakes at play, the informal constraints set by the political environment (e.g. transparent and critical debates), and the formal process for generation and verification of data. We use the RLs in REDD+ as our empirical case, and reveal RL proposals submitted to UNFCCC for REDD+ countries. While UNFCCC provide general guidelines for setting RLs, scope for systematic biases of RL exist in the definition of forest, reference period for historical deforestation, activities included, pools included, and the emission factors applied.

K-2219-03

Operational approaches for mapping tropical forest biomass and degradation patterns using optical and radar satellite data

N. Barbier (1) ; P. Couteron (1) ; F. Von Poncet (2) ; M. Schlund (2) ; C. Mathian (3)
(1) IRD–UMR AMAP, Montpellier, France; (2) Airbus Defence and Space, Immensendaad, Germany; (3) Airbus Defence and Space, Toulouse, France

Tropical forest mapping is a basic need for a wide range of users, from fields as diverse as forestry, mining and conservation or for gaining carbon credits under practices related to the REDD+ Emission Reductions from Deforestation and forest Degradation (REDD+) framework. Technical difficulties to validate cost-effective procedures to monitor forest structure from space are a hindrance to the increase in number and impacts of REDD+ projects, especially those that aim tackling forest degradation (i.e. REDD+.’s second D). Even punctual logging operations (e.g. selective logging) can lead to a persistent decline in forest goods and thus be a precursor to forest degradation. For projects quantifying and mapping dense tropical forest structure and dynamics at region to country level is a challenging, yet pressing need, notably but not exclusively for agriculture and forest degradation. The project presented, funded by EIT – Climate KIC (UE) aims at providing state-of-the-art mapping products for stakeholders requiring a reliable monitoring of tropical forest structure and derived variables, such as above ground biomass density, canopy height and degradation levels.

Despite their broad availability, medium to high resolution optical imagery (e.g. Modis, Landsat 8 or Spot 5) exhibit important limitations when it comes to quantify forest structure variation in high biomass density environments. In these settings, the technical challenge of establishing effective proxies for forest disturbance detection is difficult to overcome because of the technical challenge of establishing effective proxies for forest disturbance detection and low biomass (RMSE below 10%) estimation. Both SPOT6/7 and TanDEM-X data allow producing accurate LULUCF maps compliant with the six land categories mandatory for GHG Reporting as specified by IPCC guidelines. Thanks to information on forest structure, forest condition, stratification of the forest area into a range of forest types, including intact and degraded forests, can be achieved. These classes will represent the state of forests as a result of forest disturbance history and can be used to measure the performance and effectiveness of a wide array of intervention actions as part of REDD+ schemes.

O-2219-01

Are REDD+ subnational initiatives protective and improving the wellbeing of local stakeholders?

W. Sunderlin (1) ; SC. De (2)
(1) Center for International Forestry Research, Research and Livelihoods, Bogor, Indonesia; (2) CIFOR, Forests and livelihoods, Bogor, Indonesia

REDD+ aims to restrict forest–based greenhouse gas emissions and increase removals. In REDD+ subnational initiatives, this is to be achieved in part by restricting forest access and conversion (negative incentive) and by protecting and improving the wellbeing of local stakeholders (positive incentive). One of the main means to achieve the latter is to increase and improve forest conversion, forest enhancement, tenure clarification, and thereby higher payments to those assigned the rights to sell emissions reductions. Even without payments, the RL provides a benchmark for measuring the performance of projects and policies, with the credibility and reputation of REDD+, donors and governments being at stake. More generally, what is being measured shapes the political agenda and how different interests are being balanced in the political process. What is being counted counts.

Weather–independent TerraSAR-X + TanDEM-X radar satellite lidar data offer an interesting alternative for degradation monitoring, especially when observation frequency is critical. Amplitude change detection of satellite time series can indeed be used to automatically detect small-scale selective logging or other disturbances. Interferometric SAR features (coherence and INSAR height) derived from TanDEM-X mission data have proved to be correlated to forest structure parameters, enabling consistent forest height and biomass estimates for large areas at high resolution. In regions where accurate external terrain models are available, e.g. from airborne lidar LiDAR campaigns, the approach using INSAR height can achieve high resolution (LE90 of 7.5m) and biomass (RMSE below 10%) estimation. Both SPOT6/7 and TanDEM-X data allow producing accurate LULUCF maps compliant with the six land categories mandatory for GHG Reporting as specified by IPCC guidelines. Thanks to information on forest structure, forest condition, stratification of the forest area into a range of forest types, including intact and degraded forests, can be achieved. These classes will represent the state of forests as a result of forest disturbance history and can be used to measure the performance and effectiveness of a wide array of intervention actions as part of REDD+ schemes.

This presentation examines the performance of REDD+ in protecting and improving the wellbeing of local stakeholders on the basis of evidence in six countries, encompassing 22 subnational initiatives, 150 villages, and 4,200 households. Half the villages and households are inside and half are outside REDD+ initiatives, enabling robust comparison. Surveys were collected at two points in time (2010–2011 and then 2013–2014) enabling longitudinal comparison of the effects of various kinds of interventions. The household data was both objective (e.g. ownership of resources) and subjective (respondent perception of the causes of wellbeing change over time). Data were collected on the full range of REDD+ interventions, including restrictions on forest access and conversion, forest enhancement, tenure clarification, environmental education, conditional and non-conditional livelihood incentives, and others.
Among the findings are that REDD+ negative incentives have a noticeable effect on forest-dependent households. This is because of high average dependence on agriculture and on clearing forests through shifting cultivation to maintain soil fertility and create new farmlands. Given the high dependence on agriculture, the perceived reasons for improved and worsening wellbeing relate strongly to the covariate fortunes and misfortunes of weather (sufficiency of rain, drought, etc.) and crop and livestock abundance and survival (with considerable variation among initiatives) does have a measurable effect on wellbeing - both negative and positive - but perhaps less than one might have anticipated given that REDD+ has been underway for seven years.

Indeed, REDD+ has had many challenges getting off the ground, and has a long way to go before realizing its objectives. The obstacles are political and economic interests (at all scales of governance) tied to the conversion of forests to non-forest uses, the difficulties in producing a sufficiently large and stable stream of rewards, and considerable difficulties in establishing an appropriate tenure foundation.

O-2219-02

Calibrating carbon cycle models to determine tropical ecosystem biomass stocks: A Tier 3 certification approach

F. Maignan (1); B. Poulter (2); N. Najdovski (2); P. Claes (1); N. Barbier (3); J. Chave (4); S. Luyssaert (1); F. Von Promont (5)

(1) Laboratoire des Sciences du Climat et de l’Environnement, Gif sur Yvette, France; (2) Montana State University, Bozeman, United States of America; (3) IRD-MR AIRD, Montpellier, France; (4) CNRS, Laboratoire evoluction diversité biologique (edmr), UMR 5174, Toulouse, France; (5) Airbus Defence and Space, Geo-intelligence, 88090 Friedrichshafen, Germany

According to the latest IPCC report land use and land-use change contributes to 9-11% of total anthropogenic greenhouse gases emissions each year and thus changes in land management can provide short-term solution to mitigating climate change.

Initiatives to protect and enhance carbon stored in forests are meant to be enhanced through the implementation of the Reducing Emissions from Deforestation and Forest Degradation (REDD+) mechanism and countries are supposed to take an active role in its implementation. REDD+ access to carbon is accurately measured, reported and monitored so that carbon can be protected and efforts are remunerated through a result-based principle.

One key challenge is related to how to measure biomass with sufficient accuracy for reporting and in a cost-effective way relative to the pricing of carbon. Taking these constraints into consideration, REDD+ reporting of biomass has been categorized into:

- high uncertainty estimates, i.e. Tier 1 using global biomass density estimates,
- to moderate uncertainty, i.e. Tier 2 using country-level biomass densities,
- and to low uncertainty, i.e. Tier 3, using carbon cycle models calibrated with forest inventory data.

Here we discuss a pathway for estimating Tier 3 carbon stocks in tropical regions using a carbon cycle model, ORCHIDEE, that is calibrated with forest inventory data and constrained by remote sensing data, to estimate project-level carbon stocks and fluxes in above- and belowground biomass pools. ORCHIDEE is in a class of ecosystem models known as Dynamic Global Vegetation Models, and simulates the establishment, growth, and mortality of trees using principles from eco-physiology.

Using tropical forest inventory data, the ORCHIDEE model is calibrated to reproduce growth rates of over and understory trees, and mortality, resulting in estimates of carbon and their change over time in biomass and in soil carbon pools. Implementation of a canopy height measured from either airborne LIDAR or space-based RADAR is assimilated to ORCHIDEE to extract corresponding carbon values.

Consequently, gridded maps of aboveground biomass, belowground biomass, soil carbon, leaf area index, net primary production, and net ecosystem exchange, at the corresponding spatial resolution, or mapping unit, to that of the canopy information, can be provided for REDD+ programs fulfilling the Tier 3 criteria. We demonstrate this processing chain for sites in French Guiana, Gabon and Cameroon.

O-2219-03

Expert perceptions on cost of increasing biospheric carbon in landscapes in Finland, Indonesia, Peru and Tanzania

M. Larjavaara (1); M. Kanninen, (2)
(1) University of Helsinki, VITRI, Helsinki, Finland; (2) University of Helsinki VITRI, Helsinki, Finland

Good understanding of global variation in prices of adding biospheric carbon to landscapes could lead to a better allocation of scarce funding. Unfortunately, comparisons have been complicated by variability in ways to quantify cost and carbon benefits and how complications such as unsecure land tenure have been taken into account. Our objective was to quantify expert perceptions on cost of increasing biospheric carbon in Finland, Indonesia, Peru and Tanzania by conducting face-to-face interviews.

For this purpose we developed a simple carbon bookkeeping tool with a spreadsheet and a more user-friendly versions. We applied this future scenario carbon calculator, “CarboScen”, in 64 interviews on 8 landscapes in 4 countries. The experts represented governments NGOs, private sector and research and had their focus in national, subnational or local level. Prior to the interviews we parameterized CarboScen with best available local data on carbon densities and global understanding of speed of carbon density changes after a transition in land use. Instead of the normal, cost per sequestered unit of carbon, we asked the experts to imagine a payment of 1 USD and 10 USD paid annual for every extra ton of carbon stored in the landscape relative to a reference, business-as-usual, scenario. We then asked what kind of land use changes these payments could cause by showing carbon and land use changes suggested by the interviewee with CarboScen.

According to the perceptions of the experts land use, marginal costs of adding carbon increased rapidly as the tenfold hypothetical payment of 10 USD lead to only a two or three fold additional carbon store relative to a 1 USD payment. The perceptions on the quantity of carbon added with a given payment were roughly proportional to carbon density of landscapes. The differences to the extremely carbon dense landscapes dominated by tropical peatlands in Indonesia was approximately ten times more efficient than in landscapes in Finland and Peru and the difference to landscapes Tanzania was even greater. Based on the reasoning of the interviewees, these large differences in cost of increasing carbon were caused mainly by differences in technically maximal mitigation potential, income from forest land use changes and understanding of the assumed “good governance and efficient distribution of the funding”. It is likely that these perceptions reflect actual differences in cost of increasing carbon, and therefore should be taken into account when designing global climate change mitigation strategies.

O-2219-04

Pathways for sustainable REDD+ policies in Brazil

A. Soterroni (1); FM. Ramos (1); A. Mosnier, (2); AXY. Carvalho (3); RCM. Souza (1); M. Buurman (4); G. Câmara, (1); PR. Andrade (1); J. Pirker (5); R. Mant (6); V. Kapos (6); M. Obersteiner (5)

(1) National Institute for Space Research (INPE), Sao Jose dos Campos, Brazil; (2) International Institute of Applied Systems Analysis (IIASA), Ecosystem Services and Land Management, Laxenburg, Austria; (3) Instituto de Economia Forestal (IEF) – Geografía, Brasilia, Brazil; (4) Institute for Geoinformatics at the University of Münster (IFGI), Münster, Germany; (5) International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria; (6) United Nations Environment Programme (UNEP), World Conservation Monitoring Centre (WCMC), Cambridge, United Kingdom

Brazil’s forests constitute 13% of the global forest area and almost 30% of the tropical forest area. They account for
a significant proportion of global terrestrial biodiversity and store about 20% of global above ground forest carbon. At the same time, Brazil’s has a vigorous and dynamic agribusiness, being the world’s largest producer and exporter of coffee, sugar, and orange juice, and is highly ranked in the production and export of soybeans, ethanol, pork, beef, and poultry chicken. Reconciling these two realities presents a major challenge to scientists and policy makers that will require up-to-date and accurate land cover, land use data and ‘downstream’ tools. Within this context, the REDD+ PAC project aims at providing a global forum for sharing and improving global data on forests and deforestation drivers and developing best practices for REDD+. The objective of this paper is to present the different sources of error starting from national forest inventories. For Panama, we look at the effects of forest monitoring improvements on reductions in uncertainty. We also test five downstream proposals for discounting uncertainty of the potential credits received for reducing emissions. We compare the potential compensation received for these emission reductions to the cost of alternative upstream investments in forest monitoring capabilities.

We show that upstream improvements can noticeably reduce the overall uncertainty in emission reductions. Furthermore, the costs of upstream improvements are generally lower than the potential benefits from improved forest monitoring, especially relevant if REDD+ emission reductions are to be traded for emission reductions from other sectors.

Addressing emissions from agriculture and agriculture-driven deforestation: opportunities for land-sparing and climate-smart agriculture

S. Carter (1); M. Herold (1); M. Rufino (2); K. Neumann, (1); L. Kooistra (1); L. Verchot (3)

(1) Wageningen University, Wageningen, Netherlands; (2) CIFOR / CCAFS, Nairobi, Kenya; (3) CIFOR, Bogor, Indonesia

Deforestation and forest degradation are major contributors of global greenhouse gas (GHG) emissions, accounting for a large proportion of many developing countries’ GHG emission budgets. According to Hosonuma et al. (2012), in 13 countries agricultural expansion is responsible for 100% of deforestation. In this study we consider both emissions from agriculture-driven and emissions from existing agricultural land to assess the mitigation potential of the agriculture sector. The inclusion of emissions from agriculture-driven deforestation aligns with recent interest in including agriculture in REDD+ strategies, which aim to directly address the driver of deforestation.

Emissions from agriculture are available at the national level however despite recent efforts to map and quantify land use and land cover change (ESA, 2013; FAO & JRC, 2012; FAO, 2014; Hansen et al., 2013), we consider that these are not reliable to determine agriculture-driven deforestation. This is because deforestation in this case has a focus on land-use changes (from forest to agriculture), so deforestation data based on a forest land-use definition is not necessarily equivalent. More generally, we provide recommendations on approaches to be used to address uncertainty upstream and downstream of accounting, especially relevant if REDD+ emission reductions are to be traded for emission reductions from other sectors.

O-2219-05

Addressing uncertainty upstream and downstream of emissions reductions accounting from deforestation and forest degradation: examples from Panama and Zambia

J. Pelletier (1); S. Goetz (1); N. Laporte, (2); C. Potvin, (3); J. Busch (4)

(1) Woods Hole Research Center, Falmouth, United States of America; (2) NASA SERVIR project, Falmouth, MA, United States of America; (3) McGill University, Biology, Montreal, Canada; (4) Center for Global Development, Washington, DC, United States of America

Uncertainty in emissions and emissions changes estimates contributes significantly to the overall uncertainty in a future international climate agreement. Uncertainty can be addressed ‘upstream’ through improvements in the technologies of techniques used to measure, report, and verify (MRV) emission reductions, or ‘downstream’, by the application of discount factors to more uncertain reductions. Uncertainties is an important consideration in the REDD+ context since 1) the land-use/cover change and forest area, has not been identified as a significant factor where uncertainties are the largest, 2) many developing countries still lack capabilities for estimating stocks and flows from forests, 3) the financial mechanism planned for REDD+ has de-layered environmental improvements in their effects to slow, halt or revert forest cover change could include the use of offsets. The integration of REDD+ in the climate regime is providing a new impetus to deal with uncertainties. Agriculture-driven deforestation from fossil fuel with uncertain ER (Emission Reductions) from REDD+ remains an open question with possibly large consequences.

In the context of Reducing Emissions from Deforestation and Forest Degradation (REDD+), we provide a diagnosis of the main sources of error to greenhouse gas estimation from land use and land cover change. We then present our results using Monte Carlo analysis, using data from Panama, in Central America, and from Zambia, in Southern Africa. For Zambia, we estimate the overall error in emissions from land-use change from the different sources of error starting from national forest inventories. For Panama, we look at the effects of forest monitoring improvements on reductions in uncertainty. We also test five downstream proposals for discounting uncertainty of the potential credits received for reducing emissions. We compare the potential compensation received for these emission reductions to the cost of alternative upstream investments in forest monitoring capabilities.
Using our data on emissions from both agriculture and agriculture-driven deforestation, we consider at the national level the mitigation potential. We demonstrate the use of a systematic framework, which considers sequentially (1) the level and main source of emissions, (2) mitigation potential, (3) enabling environment and (4) risks. The level and source of emissions (1) considers the main source of emissions from either agriculture or agriculture-driven deforestation. Mitigation potential (2) assesses potential and essential support interventions in the agriculture sector or land-sparing options to address agriculture-driven deforestation. Land-sparing options are supply side interventions which reduce the need for the expansion of agriculture land. The enabling environment (3) is assessed by considering the governance, or engagement in REDD+ which can support the implementation of interventions. Risk (4) assessments identify the potential vulnerabilities of changes to the agricultural system, and we use food insecurity as an indicator. Findings estimate the mitigation potential of existing agricultural land can be up to 1 GtCO2e y⁻¹. Land-sparing interventions which close the yield gap, or rehabilitate degraded land offer opportunities to mitigate up to 1.3 GtCO2e y⁻¹ in the tropics where there is potential to close the yield gap or utilize available land and there is a good enabling environment. We highlight countries which are likely to require increased support to implement mitigation initiatives and where safeguarding is required to avoid risks to livelihoods.

This research supports discussions on REDD+ which acknowledge the inherent link between REDD+ and agriculture due to competition for land. We draw on previous debates on land-sparing, and discuss supporting policies which will be required to ensure that negative feedbacks are not realized. Although there is a need to look beyond the current novelty of this study, we find a large potential for mitigation from these options. This study gives a comprehensive overview of national emissions and mitigation priorities within the forest and agriculture sectors, which can guide decision making and investments at the international level.

The Warsaw Framework for REDD+: Implications for national implementation

C. Voigt (1); F. Ferreira (2)
(1) University of Oslo, Public and International Law, Oslo, Norway; (2) Ministério das Relações Exteriores, Divisão de Clima, Ozônio e Segurança Química, Brasilia, DF, Brazil

The adoption of the Warsaw Framework for REDD+ (WFR) in 2013 has led to a large extent to concluded negotiations on REDD+ under the UNFCCC. Together with previous decisions, the WFR sets the requirements for developing countries to access results-based finance for mitigation actions in the forest sector, while attributing to the Green Climate Fund a key role among the entities channeling results-based finance to REDD+.

This article describes the WFR and indicates some of its implications for the implementation of REDD+ in developing countries. Rather than a commentary of each decision, it outlines the WFR from the perspective of measuring, reporting and verification (MRV) processes for REDD+ actions and access to results-based payments. The WFR has further centralized these processes. Such centralization has implications for the implementation of REDD+ in particular for the actors who favored a decentralized and/or subnational approach.

Centralization in this context means a concentration of procedures under the accountability of a national authority - one of the main innovations generated by the WFR. By linking the REDD+ MRV process to national reporting obligations under the UNFCCC and related procedures, it is the need, for example, for the UNFCCC Party that ultimately assumes accountability for REDD+ results to the international community.

Furthermore, by creating a national entity or national focal point, the WFR attributes to developing countries the prerogative to determine who is authorized to obtain and receive results-based payments on their behalf. The centralization under the WFR, therefore, goes considerably beyond the national, “border-to-border” approach to implementation and MRV of REDD+ activities. Centralization may, in fact, lead to increased accountability as it implies that there is a responsible national entity and that implementation and results of REDD+ activities will be/should be aligned with other obligations under the UNFCCC, such as national communications and inventories. This, in turn, requires increasing the level of inter-agency coordination and collaboration among the multiple stakeholders involved with implementing REDD+ activities.

Such an approach also increases transparency and coordination of actions and support through the use of an info hub and the application of the same guidelines and methodologies for all activities seeking results-based finance for REDD+ activities.

The objective of this paper is to stress that the UNFCCC has adopted a centralized approach at the national level. This may require adjusting national strategies and the relationship among actors at the national level in order to obtain results-based finance. This message, we believe, has not yet reached many stakeholders implementing REDD+, resulting in several initiatives currently being labeled as REDD+ which may not be in accordance with the multilaterally agreed rules.

The oral presentation will be structured in the following way:

1. Brief introduction to the WFR
2. Results-based finance for REDD+ activities and the requirements to obtain such
3. The MRV process
4. The roles of the National Entity/National Focal Point and the Green Climate Fund in accessing results based payments
5. The importance of the WFR for national implementation: identification of (actual/potential) effects and implications

We first discuss forest cover change information for Guatemala, where we observed a deforestation rate from a high value of 1.7% measured for the period 1991–2001, to 1.3% for 2001–2006, to 1.0% for 2006–2010. This drop is not a result of a drop in the gross amount of cleared forest. Rather, it is a result of an increase in the forest regenerated, which includes new plantations and forest regeneration after disturbances such as fires and as secondary growth in abandoned agricultural fields. This is part of the result of a successful incentive program by the central government both for large and small holders (PINFOR and PINPEP), which provides monetary incentives for people and communities who plant new forests or preserve existing forest cover. Ironically, these programs have not been able to generate a single carbon credit because of problems demonstrating additionality.

In terms of the governance needed to reduce deforestation and to generate marketable carbon credits, this paper describes several significant advances in recent years. The climate change law was passed in 2013, which mandates the implementation of a series of policies to reduce and compensate emissions from sectors such as energy, industry and transportation. It includes some provisions to create a national registry for carbon-offset projects, which could set the basis for the development of an internal carbon trading system.

Beyond these national initiatives, many sectors within the country, including several government offices, are very actively pursuing the development and implementation of REDD+ initiatives to capture carbon credits. We will describe some of the governing issues under discussion, particularly the intergovernmental coordination needed to implement a proper Monitoring, Reporting and Verification (MRV) system. We will highlight the fair distribution of potential income from avoided deforestation projects in protected areas between the communities implementing the activities to reduce deforestation and the National government who is the legal owner of the land and therefore of the carbon credits to be generated. This of course has been a difficult issue to negotiate, which has resulted in tension between the communities and the central government.

Many of these issues and challenges are typical of situations encountered in developing countries around the world that have been pursuing their own policies in such as efforts to improve in enough funding to reduce or stop their deforestation problems. Unfortunately, even after many years of work, international markets for carbon credits appear to be unreachable to communities in need of funds to improve their adapting capacities. National carbon markets may prove to be a more feasible solution.

P-2219-03
Land use changes and emissions from deforestation in Guatemala: advances and challenges to prepare this Central American country for REDD+
E. Castellanos (1); D. Fernandez (1); G. Fuentes, (1)
(1) Universidad del Valle de Guatemala, Centro de Estudios Ambientales y de Biodiversidad, Guatemala, Guatemala

In spite of the fact that Guatemala is consistently listed as one of the most vulnerable countries to climate change, adaptation needs and gaps have not been identified among governmental and non-governmental organizations dealing with climate change issues. Rather, most of the work on deforestation trends in the last 15 years has focused on characterizing the potential for income from international sources derived from carbon-offset projects, first as part of the Clean Develop Mechanism CDM and more recently as part of avoided deforestation initiatives. Our research group has accompanied this process for the last 15 years and this paper will present the most important advances in terms of producing the hard data needed to show recent deforestation and reforestations trends in the country, as well as advances in defining the governance system required to implement the National Strategy Against Deforestation which is the basis for REDD+ initiatives in the country.
efficiency or improving sustainability of production reduce forest degradation, but are ineffective in reducing deforestation rates because land is cleared anyway due to demand for agricultural land. Conversely, measures addressing agricultural drivers, such as better reducing fertilizer subsidies in a targeted manner, or reducing land degradation through increased adoption of SLM measures, manage to considerably reduce deforestation rates, but have little impact on forest degradation.

Table 1. Predicted cumulative impact on forests in Zambia under different scenarios for the period 2015–2022: area deforested directly for agriculture, attributable to charcoal, and forest degradation (million hectares).

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Deforestation directly for Agriculture</th>
<th>Deforestation through Charcoal</th>
<th>Forest Degradation</th>
<th>Total: deforestation + degradation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business-as-usual</td>
<td>1.03</td>
<td>1.37</td>
<td>2.06</td>
<td>4.46</td>
</tr>
<tr>
<td>Stove efficiency (+30%)</td>
<td>1.44</td>
<td>0.97</td>
<td>1.46</td>
<td>3.87</td>
</tr>
<tr>
<td>Charcoal sustainability</td>
<td>1.69</td>
<td>0.71</td>
<td>1.06</td>
<td>3.46</td>
</tr>
<tr>
<td>Reducing fertilizer subsidies</td>
<td>0.65</td>
<td>1.38</td>
<td>2.06</td>
<td>4.08</td>
</tr>
<tr>
<td>Reducing land degradation</td>
<td>0.69</td>
<td>1.37</td>
<td>2.06</td>
<td>4.11</td>
</tr>
<tr>
<td>Potential REDD+ package</td>
<td>0.68</td>
<td>0.71</td>
<td>0.06</td>
<td>2.45</td>
</tr>
</tbody>
</table>

Simulations indicate that with a potential REDD+ package proposing a reduction of fertilizer subsidies in agro-ecological zones (AEZs) I and IIa, reducing land degradation through sustainable land management practices, combined with making charcoal production more sustainable and improving stove efficiency, approximately 1 million hectares of deforestation could be avoided in the period 2015–2022, and forest degradation reduced in an area of 1.06 million hectares.

We also report on welfare effects on small and large farm rural households in different Agro-ecological zones. The Business-as-usual scenario, as assumed in our simulations, is one where incomes grow over a period of 8 years by 120% to 150% among rural households. In AEZs I, IIa1, IIb, and III these gains are reduced only marginally (−1% to −4%) by the implementation of the REDD+ package envisaged in these simulations. Conversely, both small and large farm households in AEZ IIa2 are considerably negatively affected by the REDD+ package (−15% relative to BAU). These results would indicate that financial resources recoverable under REDD+ may need to be allocated asymmetrically so that households in AEZ IIa2 are provided with appropriate incentives for losses incurred due to constraints associated with a REDD+ package. This would be particularly important because of the 990 000 hectares of reduction in deforestation, 400 000 are in AEZ IIa2.

P-2219-05

Drivers of deforestation in REDD+ countries: Results from a pan-tropical remote sensing analysis

V. De Sy (1); M. Herold (1); F. Achard (2); R. Beuchle, (2); S. Besnard, (1); J. Clevers, (1); E. Lindquist, (3); L. Verchot (4); A. Wulder (4)

(1) Wageningen University, Wageningen, Netherlands; (2) Joint Research Centre (JRC), Institute for environment and sustainability (ies) forest resources, ISPIRA, Italy; (3) Food and Agriculture Organisation of the United Nations, Rome, Italy; (4) CIFOR, Bogor, Indonesia

Within the United Nations Framework Convention on Climate Change (UNFCCC), negotiations are ongoing to build a framework for reducing emissions from deforestation and forest degradation, and to enhance forest carbon stocks in (sub)tropical non–annex I countries (CaZs). The UNFCCC considers addressing the drivers of deforestation and degradation crucial for the development and implementation of national REDD+ strategies and action plans, and encourages REDD+ countries to identify drivers and actions that cause forest carbon emissions. Monitoring and tracking human activities that result in forest carbon change (e.g. deforestation by agricultural expansion, mining etc.) is crucial. Earth Observation data can be used to derive information on follow-up land use which generates understanding about proximate causes and drivers of deforestation. This research assesses and quantifies deforestation drivers in South America and Southeast Asia in a systematic manner, building on the 2010 global Remote Sensing Survey of the FAO Forest Resource Assessment. Deforestation drivers are assessed by visual interpretation of forest change patches depicted from satellite imagery to derive follow-up land use of deforestation from 1990 to 2005. This allows to quantify the proportion of deforestation drivers which are then used to assess forest carbon emissions per driver. The focus for this conference will be on presenting the spatial distribution, trends and trajectories of regionally specific drivers of deforestation and associated carbon emissions.

P-2219-06

The action of indigenous peoples of the Amazon and the political economy of environmental change

D. Delgado Pugley (1)

(1) Université Catholique de Louvain, Etudes du développement, Louvain, Belgium

This communication aims to analyse the attempts to reform land and resources management policies that emanate from the global climate regime and concern the Upper Amazon region. It examines some of the coalitions, alliances, and negotiations among social movements that have accompanied and shaped the process of climate change politics from the preparation of COP 15 in Copenhagen (2009) to the preparation of COP 21 in Paris (2015). Using a form of multi-actor analysis, it contrasts the involvement in REDD+ (reducing emissions from deforestation and forest degradation in developing countries) negotiations of two transnational movements: the Indigenous peoples movement, and the forest conservation coalitions. How do indigenous peoples of the Amazon region have occupied the political space created by climate change negotiations? Have they succeeded in gaining recognition and better access to resources and services within national boundaries? Do states, environmental organizations and indigenous peoples have found ways to avoid deforestation?

By following key mobilization processes of indigenous peoples during the period studied (2010–2014) in Peru, Colombia and Bolivia this paper aims to show the impact the indigenous peoples have had as actors of the conservation of Amazonia. This communications aims to contribute to the understanding of the role of indigenous social movements in normative global orders by focusing on the way this political transformation has been undertaken by the human and the environment engaging non state actors on this task.

P-2219-07

Do REDD+ social safeguards reach the ‘right’ people?

J. Jones (1); B. Ramamonjiosa (2); N. Hockley, (1); A. Rasoamanana (2); R. Mandimbiniaina (2); S. Rakotonarivo (1); M. Poudyal, (1)

(1) Bangor University, School of environment, natural resources and geography, Bangor, United Kingdom; (2) University of Antananarivo, Faculté des sciences de l’agronomie, Antananarivo, Madagascar

There is extensive debate about the potential impact of the climate mechanism REDD+ on the livelihoods and welfare of forest-dwelling people. To provide carbon credits, a forest carbon scheme must slow the rate of emissions. If this is achieved by slowing the expansion of agricultural land then there is clearly a long-term cost to forest-dwelling populations. Significant investment in REDD+ and has a number of pilot projects with World Bank support. We focus on one such REDD+ pilot - the Ankeniheny Zahamena Corridor (CaZ). Some 1,500 households around the corridor have been identified under World Bank safeguards as containing ‘project affected people’ (PAPs) and are receiving individual income generation projects as compensation. There has been controversy as to how such people are identified. We carried out intensive field work in one administrative unit, mapping the location of each household and selected...
a random sample stratified by location for detailed household interviews about livelihoods, food security, and assets. We compared the characteristics of households identified as eligible for compensation with those not identified as eligible. We found that people living closest to the forest, with livelihoods most dependent on the forest, were less likely to be identified as PAPs while those living closest to the village centre and with powerful social positions were more likely. We interpret this as evidence of exclusion and the inequitable distribution of benefits. Being aware of such extremely poor information available on local populations (even the location of quite significant villages is not available from maps), and the unwillingness of people's whose livelihoods are dependent on illegal agricultural land to self-identify, it is unsurprising that the official process faced challenges. We question whether the approach of identifying and compensating particular households is politically, socially, and ecologically sustainable and discuss what this means for ensuring that REDD+ can be implemented without harming local people's livelihood.

P-2219-08
Forest Degradation, Regeneration, and Farmers' Income: Evidence from Smallholders' Decisions in Vietnam
M. Li (1); A. De Pinto (1); T.S. Thomaz (2)
(1) International Food Policy Research Institute, Washington, DC, United States of America; (2) International Food Policy Research Institute, Washington, United States of America

The interactions between agricultural production, forest conservation, and economic development are complex. Higher agricultural output prices and technologies that increase yield are expected to increase farmers' income and stimulate forest clearing, while higher agricultural input prices have mixed effects. On the one hand, an increase in the opportunity costs of labor makes agriculture less profitable and can reduce pressures on forests. On the other hand, raising costs associated with fertilizer price may induce shift to extensive production systems that use more land and less fertilizer. This study presents new evidence about these relationships by focusing on forest degradation, regeneration, and farmers' income in Vietnam.

Vietnam has recently experienced forest transitions from net deforestation to net reforestation as many other countries and the United States underwent in the past. From 2000 to 2010, approximately 1.6 million hectares of timber forests were restored in the country. Reforestation, however, has not prevented deforestation of useful and medium timber forests, the area of which declined by 0.16 million hectares and 0.27 million hectares, respectively. In the meantime, the area of agricultural land increased by about 2 Mt. Total agricultural land use is expected to expand over the coming decades. Thus, understanding how agricultural sector affects forest resources and how these changes in turn affect rural economy have important implications for policy making.

The purpose of this study is to empirically examine the impacts of agricultural production on forest degradation and regeneration in Vietnam in the 2002-2010 decade. We compile highly detailed forest–soil–climate data for two years 2000 and 2010, which are derived from fine–scale vector data, field surveys, satellite data, and household surveys. To this end, we use the Vietnamese Household Living Standards Survey (VHSL), a nationally representative survey performed by the National Institute for Research in Agroforestry (ICRAF). The forest data are merged with ~40,000 household-level observations in ~3,000 communes from the 2008 Vietnam Household Living Standards Survey (VHSL), a nationally representative survey performed by the National Institute for Research in Agroforestry (ICRAF).

Our study makes two contributions to the literature. First, the coexistence of forest degradation and regeneration in Vietnam provides an opportunity to study the influence of all of these factors on farmers' income at the micro level. The detailed forest data allow identifying changes in forest species, which helps to distinguish forest degradation from restoration. This is particularly important because to assess the impact of forest resource change on climate change, it is necessary to understand how forest carbon density changes. An oversight of the spatial pattern of forest species may cause misleading estimates.

Second, this study provides empirical evidence of the interactions between agricultural production, forest regeneration, and farmers' income under forest change. Land use change is arguably the most pervasive socioeconomic forces affecting economic and environmental systems. These forces drive a large portion of global economic and environmental systems. Land use change is associated to deforestation and degradation of savanna woodlands. Within higher latitudes, mean AGB in non forest class was found to be logically lower but far from negligible. Therefore, SAR data could support REDD+.
Large scale agrofuels projects in the Tana River Delta, Kenya: an assessment of their purported climate benefits and their impact on ecosystem service delivery for the local population

L. Mukhwana (1); O. Hamerlynck, (2); Q. Luke, (3); S. Duvail (4); D. Nyingi (5)


Over the past decade, the Tana River Delta in Kenya has attracted the interest of agrofuels investors looking to start large-scale development projects for agro-fuel production. Most of these projects have failed either to commence or to thrive but others are continuously coming up. From 2010, Bedford Biofuels a Canadian company acquired 160 000 ha of land on the terraces surrounding the delta with the plan to convert it to a vast Jatropha curcas plantation. The rationale behind the investment was that the Jatropha is a productive and could be used to produce cheap and climate-friendly agro-fuels. In order to check this assumption a survey was conducted in May 2012 on the project area, assessing its woody vegetation and standing carbon stocks in order to compare their potential for REDD+ schemes with the proposed direct land use change by conversion to agro-fuel farms. This carbon stock assessment, combined with a wider analysis of the ecosystem services provided by the delta terraces, have shown that there are more opportunities for the local communities in their current use of the Tana Delta land than in the option of the conversion to a vast Jatropha field. In this presentation, we would emphasize on the risk of developing large scale agro-fuels projects without properly taking into account the various values of the ecosystem to the local users and without considering the existing customary land tenure rights. Resilience to climate change is more likely to improve when land rights are secured for traditional semi-nomadic livestock keeping and participatory land use planning with all use planning with all users.

The development of FOREST: a Fully Optimised and Reliable EmissionS Tool

A. Nouillas (1); N. Barbier (2); A. Barker (3); P. Bicheron (1); A. Capel (4); N. Chenet (4); M. Deheza (5); C. Mathian (6); F. Maipign (7); N. Najdovski (8); J. Nightingale (3); N. Origo (3); F. Von Poneck (9); B. Poulter (8); M. Rageade (4); S. Schlund (9)

(1) Institute for World Forestry, University of Hamburg, Hamburg, Germany; (2) Institute for World Forestry, Johann Heinrich von Thünen Institute, Hamburg, Germany

The objective of this poster is to present the different scientific components of the FOREST (Fully Optimised and Reliable EmissionS Tool) project that gathers since 2014 the expertise of seven European institutions working together thanks to funding provided by the project funded by the EIT Climate KIC.

The FOREST project aims to positively respond to the growing demand of forest carbon stakeholders for trusted, fully integrated and cost effective Measuring Reporting and Verification (MRV) service components, enabling forest carbon projects and initiatives to achieve carbon goals, i.e. emission reduction and/or stock enhancement. It brings essential building blocks for such services including the observations from space, the local in-situ ground measurements to calibrate these observations, the forest maps and the theoretical model needed to estimate and make the carbon sequestered in forested areas. By providing cost effective capacities driven by market and end users, the project will improve the process of MRV for forest carbon at project/national scale.

Remote sensing by satellite is a practical way to get large geographical and ideally global information about forests, especially in remote areas that are difficult to access. Satellite imagery, optical and radar, is used to basically determine land cover/use and land cover/use changes and to map forests. It provides essential information that is used:

- to establish historical forest maps
- to feed carbon model
- to design / optimize sampling scheme
- to understand drivers of deforestation & degradation
- to measure performance of projects and effectiveness of public policies

Although pre-operational solutions exist, some issues such as the lack of standardization, the overall cost (transaction and implementation) or the overall achievable quality & reliability can hamper the development of the forest projects and undermine market attractiveness. There is considerable room for improving existing methods and to design innovative solutions, for developing solutions that bring effective value to money, for tackling pending issues that are key priorities in the international negotiations such as degradation monitoring.

The FOREST partners are currently working on developing ‘forest mapping’ and ‘carbon modelling’ services relying on:

- Provision and processing of Earth Observation (EO) data (optical and radar) for deriving primary products required in the assessment of forest cover and change,
- Determining canopy texture features at local and regional scales based on these EO data for a better characterization of forest structure
- Developing the ORCHIDEE carbon flux model which is already recognized by the scientific community towards its operational implementation in national and regional REDD+ MRV systems,
- Quality Assurance, calibration and validation strategies for each step supported by existing ground based in situ measurements or products accuracy assessment already established through robust methodological practices will allow to provide an uncertainty for the overall services.

In order to assess the market size for this technology and to evaluate the potential savings for project developers a market analysis will be performed.

The poster will present the technical approach of this project as well as the different outcomes that can be achieved through this interdisciplinary collaboration.
The presented presentation deals with one of the main issues for policy makers regarding the the combat against global climate change in the realm of tropical forests: the realization of a credible mechanism to reduce emissions from deforestation and forest degradation (REDD+).

One of the major topics within building the framework for REDD+ are uncertainties associated to estimating reduced emissions from deforestation and forest degradation (MRV) system. IPCC requires applying the principle of conservativeness to address these uncertainties (IPCC 2006) by constructing a reliability interval around a carbon stock that would utilize the lower bound of the interval for reporting. This, however, can have severe consequences to countries that are willing to participate in the REDD+. Despite successfully reducing emissions, some countries may have no chance to achieving benefits from REDD+ due to high uncertainties and the application of the principle of conservativeness (Köhl et al. 2009, Plugge and Köhl 2012, Plugge et al. 2013). In consequence, this would preclude many countries from participating in REDD+.

Broad participation is, however, one important prerequisite to make the mechanism a success, e.g. to reduce undesired displacement of emissions (leakage) as explicitly mentioned in the safeguards (UNFCCC 2011) or to achieve the overall 2°C goal. Consequently, to be able to participate in REDD+, countries need to implement higher MRV and reporting systems standards (Tier 2 or Tier 3). At the same time our results show that countries would make a profit by maintaining low reporting standards with associated high uncertainty. Nevertheless, continuously advancing in the MRV and reporting standards is a prerequisite for participation in REDD+.

IPCC. IPCC guidelines for national greenhouse gas inventories (Institute for Global Environmental Strategies (IGES), Hayama, Japan, 2008).

Köhl, M., Baldauf, T., Plugge, D. & Krug, J. Reduced emissions from deforestation and forest degradation (REDD): a climate change mitigation strategy on a critical track, Carbon Balance and Management 4 (2009).


Grassi, G., Federici, S. & Achard, F. Implementing conservativeness in REDD+: is realistic and useful to address the most uncertain estimates, Climatic Change 119, (2013).

Land-use change, mainly the conversion of tropical forests to agricultural land, is a massive source of carbon emissions and contributes substantially to global warming [1]. The future development of forest area is uncertain, but deforestation is projected to persist as a significant emission source in the absence of new forest conservation policies, especially under increasing demand for agricultural commodities. Despite the general scientific agreement on environmental benefits of forest conservation, and although the United Nations Framework Convention on Climate Change (UNFCCC) has affirmed the potential role of forests in stabilizing the global climate, no global action has yet emerged to conserve natural forests. One key issue for the implementation of REDD (Reduced Emissions from Deforestation and Degradation) is how to address leakage of emissions [2]. Without full participation of all countries in a forest conservation scheme, emission reductions in one location could result in increased emissions elsewhere, as agricultural expansion, the main driver for deforestation, could just be displaced rather than avoided (international leakage). However, international leakage is not only relevant in the context of regionalized forest protection efforts. Another risk associated with a global REDD scheme that so far has not been quantified in the literature is the shift of land-use pressures to non-forest ecosystems (non-forested leakage), simply because they are the only remaining resource for agricultural expansion. Such ecosystems may also be rich in carbon. First, areas under natural vegetation, such as shrublands and savannas, can also store considerable amounts of aboveground carbon. Second, carbon-rich soils also play a major part in the terrestrial carbon balance and have to be taken into consideration. For this reason, carbon stocks decline strongly after land is converted from grasslands and pastures to cropland. Finally, agricultural activity can reduce carbon sequestration by preventing regrowth of natural vegetation on abandoned agricultural land.

In this study, we estimate land-use and associated carbon stock dynamics for different global terrestrial carbon policies at global and regional scale using the land-use optimization model MAGPIE (Model of Agricultural Production in a Globalized Economy) for REMA (Reduction of Emissions from Deforestation and Degradation). We show that a global forest policy could reduce carbon emissions by 77 Gt CO2, but would still allow for decreases in carbon stocks of non-forest land by 96 Gt CO2 until 2100 due to non-forest leakage effects. Furthermore, the abandonment of agricultural land and associated carbon uptake through vegetation regrowth is hindered. Effective mitigation measures thus require financing structures and conservation investments that cover the full range of carbon-rich ecosystems. However, our analysis indicates that greater agricultural productivity increases would be needed to compensate for such restrictions on agricultural expansion.

References
Ensuring community benefits; case study of REDD+ in Ghana

AR. Saeed (1)
(1) University of Reading, Geography and Environmental Science, Reading, United Kingdom

In the last decade, United Nations negotiations have been going on using forests to mitigate climate change via the mechanism known as Reduced Emissions from Deforestation and Forest Degradation plus the added value of conservation, enhancement of forest carbon stocks and sustainable forest management (REDD+). With support from organisations like the World Bank and the collaborative efforts of UNDP, UNEP and FAO, forest countries across the globe have started to get REDD+ ready. Getting REDD+ ready includes running pilot projects and implementing other readiness initiatives to feed into the systems and strategies countries are laying out for REDD+ and to reform already existing climate and forest governance institutions. The purpose of this research is to understand how local communities harness such new carbon economy opportunities (or not). The study is a multi-sited case study approach in Ghana employing systematic literature review, semi-structured interviews, actor mapping, focus groups and document analysis as the main methods of identifying what can be learnt at the international level from the local level implementation of such carbon mechanisms.

Future scenarios for the north of Amapá State considering REDD+ as a conservation tool

E. S. Leite (1); V. G. Caluque (2); L.G.D. Aguiar (3); VF. Santos (4); L. Maritorto (5)
(1) Empresa Brasileira de Pesquisa Agropecuária – EMBRAPA, Embrapa Amapá, Macapá, Brazil; (2) Ativos Socioambiental, Brasilia, Brazil; (3) Universidade Federal de Pelotas, Meteorologia, Pelotas, Brazil; (4) Instituto de Pesquisas Científicas e Tecnológicas do Estado do Amapá – IPema, Lab. de sensoriamento remoto e análises espaciais aplicado a ecossistemas. aquáticos – Iasa, Macapá, Brazil; (5) Embrapa, Agrometeorologia, Belém, Brazil

The ecosystem services provided by forests are important for ecosystem maintenance, and support, protect and affect the activities and human well-being. Much of the forests in the northern region of Eastern Brazil are under some type of protection, being one of the most pristine areas of the Amazon. In Amapá these forests may be threatened by being in an area of the border with French Guiana, where the current political development of the State is being targeted, resulting in actions that modify the current scenario and pressure on natural resources in the region.

This study assessed how the provision and maintenance of ecosystem services such as carbon stocks can contribute to local and regional sustainable development. This study allowed creating development scenarios for the northern region of Amapa to 2030. These results contribute to the discussion of a policy to subsidize programs aiming at reduction of emissions from deforestation and degradation (REDD) and payment for ecosystem services (PES) implementation, by defining priority areas in the border region between Amapa and French Guiana.

This study was conducted in the northern region of the State of Amapa across the municipalities of Calçoene and Oiapoque. This area lays within the Guyana Shield, which is characterized by a low population density, difficult access to remote forest areas and for being a geological and biological unit where high levels of endemism and biodiversity exists.

The opportunity cost of avoiding forest conversion was generated using information of the net present value (NPV) of four land use activities (forest, cattle ranching, and gold mining) and the general carbon stock values of these land use categories. This latter data was associated with a land transition matrix, processed using the REDD Abacus SP software. The output was the differences derived from the returns of the forest and those land uses that will replace it, with differences in carbon stocks of the emissions avoided by not converting the forest to other uses. Three opportunity cost scenarios were modelled, from which a sensitivity analysis was done and based on these results, scenarios were simulated.

The cumulative reduction of forest cover in 2030 was higher in the pessimistic scenario compared to the other two simulated scenarios. In the optimistic scenario, we observed a clear effect in reducing deforestation by implementing a program of PES-REDD+, which resulted in a level of deforestation close to the historical projection.

The opportunity cost of avoiding the conversion of land use was the current per ton of carbon price (R $ 14.6/tCO2e = $ 7.5/tCO2e) varied between R $ 3.00/tCO2e and R $ 2410.00/tCO2e, corresponding to a potential annual reduction of emissions between 0.14 and 0.02 tCO2e per hectare. The largest potential abatement of emissions derived from avoiding forest conversion to cattle ranching activities (0.14 tCO2e.ha–1.year–1) at a cost of R $ 300/tCO2e. Included variations in profitability (NPV) of land uses associated with the deforestation scenarios of livestock continue to be the most attractive activity for the implementation of a REDD+ project.

In modeling the possibility cost in terms of the three scenarios of deforestation, we found that the pastures activities remained as the most attractive activity for developing REDD+ projects, with an average cost of R $ 4.93 ± 2.73/tCO2e for the three scenarios, at the current average price per ton of carbon. This shows the potential of establishing a program of payment for environmental services with small cattle ranching producers which practice a low-productivity activity.

The balance between the implementation of conservation policies and economic development will give the State alternatives for successfully implement REDD+ mechanism. However, this success will depend on strengthening of institutional capacities and land regularization measures, which will provide the necessary information to the construction of the policies and the REDD+ strategy of the state. This study gives various elements to support the construction of such a policy, especially for the construction of its baseline.
be acknowledged as a long-term driver of economic, social, political and cultural transformations.

Ecosystem services are often valued for their immediate material or cultural benefits to human well-being, although many medium- to long-term ecosystem services that sustain such benefits (referred to as regulating and supporting services in the Millennium Ecosystem Assessment terminology) must be considered. In the context of climate change and expected dramatic and likely abrupt impacts on ecosystems and on societies, an additional role for ecosystems towards human well-being has been recognized, and referred to as Ecosystem-based Adaptation (EoA). Following one step further, a broader framework can be proposed for the identification, understanding and management of so-called adaptation services. Adaptation services are defined as the benefits people derive from the capacity of ecosystems to moderate and adapt to the effects of climate change.

Adaptation services differ from ecosystem services by formally recognizing the intrinsic ability of ecosystems to provide valuable services for societal adaptation by (i) buffering risks, (ii) providing options and (iii) transforming. In contrast to ecosystem-based adaptation, which has been addressed under decision-making status quo, for adaptation services to emerge and inform effective adaptation, new decision contexts that incorporate the integrated transformation of values, rules and knowledge are required. In particular, new transdisciplinary knowledge will be required to drive such social changes, and to achieve consensus on decisions and actions.

As a first step, the uptake of the concept of adaptation services by scientists, managers and policy makers requires proof of the concept and identification of key underlying mechanisms so to move beyond a conceptual definition and iconic story lines, and to develop innovative management solutions. In this presentation we will demonstrate such a proof of concept by means of a common methodological framework applied to ecosystems from a range of latitudes and with key roles in ecosystem-based adaptation to climate change.

This framework facilitates implementation of an adaptation services approach and enables synthesis across case studies. In particular, using such a comparative approach we propose hypotheses on functional mechanisms underpinning adaptation services required to support transition and transformation of socio-ecological systems, such as the role of keystone species and keystone functional groups or the role of different types of response diversity. Landscape connectivity already does, and is expected to play a key role for transition and/or transformation of fragmented systems.

We then identify initial principles for the management of adaptation services that range from the management of pre-existing adaptation services that will support adaptation to climate change, to planned adaptation by steering new adaptation services, and to the restoration of adaptation services in degraded ecosystems. Lastly we discuss alternative adaptation pathways that could meet multiple objectives of nature conservation and human well-being.

K-2220-02

Ecosystem services in forest conservation for climate change mitigation: a cross-site analysis of REDD+ projects

J. Förster (1) ; R. Seppelt, (2) ; T. Vaclavík (2)

(1) Helmholtz Centre for Environmental Research – UFZ, Dept. computational landscape ecology / dept. environmental policy, Leipzig, Germany; (2) Helmholtz Centre for Environmental Research – UFZ, Computational landscape ecology, Leipzig, Germany

This presentation is part of parallel session 2220 «Landscape & ecosystems adaptation» with the title «Landscape level adaptation and mitigation: integrating science, policy and practice».

The presentation provides insights into the role of ecosystem services in projects for reducing emissions from deforestation and forest degradation (REDD+). The role of ecosystem services in the design of 39 REDD+ projects was analysed in a cross-site comparison, revealing opportunities and trade-offs in delivering climate change mitigation, adaptation and sustainable development at the landscape level.

REDD+ has become a well-established building block of climate change policies under the UNFCCC. Policies require REDD+ projects to comply with safeguards for maintaining and enhancing forest ecosystem services. This cross-site analysis of REDD+ projects indicates, that the majority of REDD+ projects do address multiple ecosystem services, expected to contribute to climate change adaptation and sustainable development, with benefits to local communities. However, the analysis also reveals challenges when it comes to the effectiveness of REDD+ projects in providing benefits to local communities at the same time.

The findings of this analysis inform on 1) how REDD+ projects comply with safeguards defined in UNFCCC policies, and 2) how REDD+ projects contribute to mitigation and adaptation at a landscape level.

K-2220-03

REDD+ delivery models at landscape level: the crucial role of private sector, for session «N’ 2220 – Landscape & ecosystems adaptation» with the title «Landscape level adaptation and mitigation: integrating science, policy and practice»

I. Nhantumbo, (1)

(1) International Institute for Environment and Development, Natural resources group, Edinburgh, United Kingdom

Addressing REDD+ requires interventions at scale to address the drivers of deforestation and forest degradation within large landscapes where competing users and land uses provide an opportunity and a challenge in reducing emissions. IIEE has been conducting research to understand the role and risks of private sector in REDD+ as well as the institutional and policy frameworks that govern their involvement in implementation of REDD+. In particular focus was on carbon rights and benefit sharing. A database of 115 REDD+ initiatives in Africa, Asia and Latin America was constructed. Case studies from DRC, Mozambique and Tanzania provided for detailed analysis of the legislations and institutional arrangement in place at national and local level. This presentation will share some of the key findings related to issues of carbon rights and benefit sharing as clarity on this is core to REDD+ delivery models that are inclusive, equitable and sustainable. In addition, IIEE is conducting research and testing REDD+ delivery models in Beira landscape Corridor in Mozambique including three provinces (Manica, Sofala and Zambezia) in which four models were identified to address key drivers in agriculture, biomass energy, timber and non-timber harvesting practices. The role of private sector in implementing sustainable land use changes to reduce emissions is important. However, it has been equally acknowledged that public finance for REDD+ can only do so much. Private capital is needed to provide the impetus for large scale and sustainable investment required for meaningful and measurable emissions reduction. There are questions however: what is the formulae for this private capital and who are the winners and losers? Is the model economically viable as well as socially and environmentally sound? Are the local small scale enterprises requiring the capital to invest in sustainable and uses likely to be a conduit for generating profits for financiers alone or they stand to gain as well? What safeguards need to be in place to secure win–win solutions?

O-2220-01

The role of ecosystems in Disaster Risk reduction

J. Kloos (1) ; J. Frélichová (2) ; S. Van Der Meulen (3) ; F. Renaud (4) ; E. Lorencová (2) ; Z. Sebesvari (1)

(1) United Nations University, Institute for environment and human security unu-éhs, Bonn, Germany; (2) Czechglobe, Department of human dimensions of global change, Brno, Czech Republic; (3) Deltares, Utrecht, Netherlands; (4) United Nations University, Institute for environment and human security (unu-éhs), Bonn, Germany

Ecosystems have the capacity to play an important role in disaster risk reduction (DRR) as well as in climate change...
adaptation (CCA). In the context of DRR, ecosystems contribute to hazard mitigation as well as to the reduction of the so-called “underlying risk” as outlined in the Hyogo Framework of Action (HFA, 2005). Although engineered structures are still preferred and promoted by planning authorities, several disaster risk reduction. In many cases, there is an increasing number of applications of ecosystem-based solutions in disaster risk reduction worldwide. Similarly ecosystem-based adaptation (EbA) measures are being recognized. After discussing relevant concepts and identifying potential synergies, this presentation will showcase a number of applications in a range of contexts based on the existing system of ecosystem services (ESP) research group. For selected cases, the role of ecosystem services and how they contribute to reducing risks and vulnerabilities and/or contribute to climate change adaptation will be presented. This presentation will also highlight linkages to other ESP working groups that provide solutions for disaster risk reduction from specific ecosystem perspectives, such as for fresh water and marine environments.

**O-2220-02**

A Community Forestry-landscape based approach to climate change adaptation

R. Pairojmahakij (1); R. Triraganon, (1); D. Gritten, (1); B. Poudyal, (2)

(1) RECOFTC, Bangkok, Thailand; (2) RECOFTC, Kathmandu, Nepal

International debate on the role of forests in climate change has thus far mainly focused on their potential to mitigate Greenhouse Gas emissions (GHGs), particularly through the REDD+ mechanism. However, the role of forests in contributing to climate change adaptation has been gaining recognition. In addition to the efficiencies in linking adaptation and mitigation funding and project activities, a key rationale for focusing on forest landscapes for adaptation is the reliance of approximately 450 million people on forests in the Asia Pacific region alone. The contributions of forests to the livelihoods of these local communities is significantly higher than previously thought and thus a major contributor to their adaptive capacity. Conversely, local communities may prove to be critical in on the ground implementation of activities to support ecosystem-based adaptation. In this context is of particular importance as a modality for providing multiple benefits to local communities and the various assets required for adaptive capacity in a context of climate change. The research article present a CF based climate change adaptation framework, which is grounded in 10 case studies in Cambodia, Indonesia, Nepal, Thailand, and Vietnam, and the recent piloting of this framework in the Terai of Nepal.

**2220–POSTER PRESENTATIONS**

**P-2220-01**

Ecological services as determinants of social-ecological system transformations: Dojran lake, Macedonia

L. Ilievá (1); C. Giupponi (2); D. Bojovic, (1)

(1) Ca’ Foscari University of Venice / Euro–Mediterranean Centre on Climate Change, Venice, Italy; (2) Ca’ Foscari University of Venice, Venice Centre for Climate Studies, Venice, Italy

Global environmental change often triggers abrupt and irreversible ecosystem shifts resulting in transformations of social-ecological systems. The capacity to adapt to such variable and uncertain conditions is a unique learning opportunity to better understand factors underpinning system resilience to shocks. This study examines a social-ecological system through the lens of ecosystem services and their role as determinants of a transformation.

The project Integrated Water Resource Management (IWRM) at Dojran lake in Macedonia applied the ecosystem services framework to examine the impacts of sudden natural disasters affecting Dojran Lake in Macedonia. Once a significant site in the Balkan peninsula, known for its water health benefits, fisheries, and abundant hydrological resources for agriculture and surrounding settlements, the lake has experienced two extreme shocks resulting in flood (1955 – 1956) and drought (1989). The shocks were detrimental for the lake, leading to the collapse of its littoral zone, and significant biodiversity loss. All these resulted in long-term impacts on the social–ecological system and overall economic downturn associated with collapse of the local fisheries industry and decreased tourism.

In the attempt to better understand how did the abrupt transformation affect ecosystem services and human wellbeing, we collected and analysed information through the following activities:

1. identification of main stakeholders at Dojran lake and analysis of their relevant role in the process of transformation;
2. analysis of social, ecological, and economic factors defining the current state of the system;
3. identification and prioritization of ecosystem services and their current conditions;
4. exploration of the stakeholders’ visions about desired future social–ecological pathways and consultation of the development strategies of the local government.

The collected information contributed to the development of a holistic picture of the actors and components necessary to understand the resilience of the system, emphasizing the dynamic character of the internal transformation processes.

The research was further guided by the principal question of how the listed disaster or extreme events can provide insights for the management and conservation of the altered social–ecological system. Results show that the state of ecosystem services provision has dramatically decreased; nevertheless they continue to be determinant for local communities’ wellbeing and an indicator for their adaptive capacity. We identified recreational services, fisheries and agricultural production as the key ecosystem services. Their intensified exploitation, however, is guided by past livelihood patterns, which can hardly be supported by the current state of the ecosystem and which can be exposed to further risks in the perspective of climatic changes. Although the visions about the prospects of development in the area were rather heterogeneous, there is a common shared awareness of the need to preserve and valorise key ecosystem services.

The analysis of past sudden social–ecological transitions through an ecosystem services approach provides a comprehensive framework for the research of adaptive and coping capacities inherent in the system and the identification of its main vulnerabilities. These results represent a step forward towards identifying enabling factors to incorporate ecosystem services in the development process of the area, which will strengthen the capacities for adaptive management of social and ecological systems in view of possible future shocks.

**P-2220-02**

Impacts of land cover changes on ecosystem service delivery using remote sensing, GIS and social innovation tools at Duiwenhoks catchment

M. Tshindane (1)

(1) South African National Biodiversity Institute, Climate Change Adaptation Division, Western Cape, South Africa

Historic spatial land cover databases consisting of maps and land use patterns are important tools for monitoring impacts of land cover change. Such a database was constructed for Duiwenhoks Catchment in the Western
Cape, South Africa from 1940 to 2010 in order to assess land cover dynamics at a large scale (70 years). This, coupled with attribute climatic data and streamflow dynamics will be useful in modelling future hydrologic patterns, ecosystem services sustenance and resilience to climate and anthropogenic impacts such as floods and increased vegetation clearing for agricultural purposes respectively in the 21st century (2050) using ACRU. To achieve this, black and white Aerial Photographs (AP's) were used to build the land cover maps roughly in a decadal series (1940, 1950, 1960, 1970, 1990 and 2010) with the exception of 1980 due to bad raw datasets which was technically deemed impractical to be used for this study. Research tools for the project were advanced software in GIS (ArcGIS 10.1) and Remote Sensing (ERDAS Intergraph 2014 and ENVI 4.4) to perform desktop applications like geo-referencing, image cropping, mosaicking, projection and post classification. The project used remote sensing tools for textural analysis, Principal Component Analysis (PCA), supervised and unsupervised classification to build the spatial land cover maps. An error matrix using 80 sampling points per land cover class and ground truthing was used to quantify the degree of correctness resulting in a 60% overall classification and 58% Kappa index. Furthermore, interviews with the farmers, long-standing residents, private land owners, and the Duivenhoks Water User Association and conservation planners were used to assess trends and the effectiveness of environmental policy and ecosystem based adaptation mechanisms that are foreseen in by different organizations in the study area. Findings of the study show a loss of natural vegetation from the 1940’s especially in riparian zones of the middle catchment. An observed increase in dam construction also indicates the increase in demand for irrigation water for both crops and livestock production. With good national and international policies in place to promote environmental sustainability in South African Water Catchment Management Areas, there is great potential for rehabilitation and conservation of ecosystems and the physical environment. However, the limitation of application of policy at a local fine scale level is one of the reasons which appear to lead to failure of preventing unsustainable land cover change such as in riparian zones. Firstly, catchments differ in their heterogeneous statuses, and environmental issues become diluted in terms of their relevance to local development due to a weak alignment of policies and legislation (Sitas et al. 2013). The on-going gabion construction project (Duivenhoks Goukou Wetland Rehabilitation project) is one of the success adaptation mechanisms by being rolled out in the Duivenhoks catchment because prior to its conclusion, several of the objectives like maintaining streamflow and halting river bank erosion appear to have been achieved. Additional to the gabion construction adaptation response, the alien vegetation clearing exercise has also proved to be yielding substantial results in the middle catchment. However, at the upper catchment below the Langeberg Mountains, the alien clearing programme should have immediately followed up the clearing exercise by planting endemic plants that will protect the soil from further erosion due to its looseness and exposure to runoff. Therefore, alien clearing should take note of the seasons in which to act on because performing the exercise in mid–winter makes the exposed soil erosion debris which waits to be washed into the main river and other feeding streams.

P-2220-03

Traditional plant-phenological observations at the Hungarian Meteorological Service

E. Vincze (1)

(1) Hungarian Meteorological Service, Budapest, Hungary

The relationship of the vegetation and climate is obvious from the first observations of the nature. Climate change has a strong impact on the flora of each country, which can be followed by the study of phenology. The task of plant–phenology is to observe and analyse the periodically recurring biological processes such as budburst, flowering, fruit opening, and leaf fall. This is the scientific discipline, which is able to link vegetation dynamics with climate variables.

Phenological observations in Hungary started in 1871. The observation system of the Hungarian Meteorological Service (OMSZ) collapsed and revived time by time, until it was closed because of financial problems in 2000. Due to the reorganization of the institute, unfortunately, a part of the datasets were destroyed. Between 2009 and 2014 within the framework of a scientific research fund we had an opportunity – beside the main tasks of the project – to study the archive records.

In the last two years we collected detailed statistics about the digitalized and the only-paper datasets and tried to methodize the whole available digitalized and paper–based database. The paper will present the archive phenological data collection of the Hungarian Meteorological Service between 1871 and 2000.

P-2220-04

Economic Contribution of Communal Land Restoration to Rural Livelihood; a Case Study in Ethiopia

YT. Weldesemaet (1)

(1) Watersheds Organisational and Livelihood Affairs Support, Research and Development, Addis Ababa, Ethiopia

Restoration of natural capital in areas with conservation interest has significant potential in the conservation of biodiversity and thereby increasing the economics of the area. Despite such qualitative assertions, quantitative accounting of restoration areas is hardly ever assessed in Ethiopia. Therefore, this study attempted to quantify the economic net benefits of the restoration of degraded community conservation area by comparing the cost of restoration inputs; with the income generated from the restoration outputs. The restored conservation area cost and benefit are projected temporally to 2025 the time when the restoration outputs yield maximum and spatially to the large-scale communal land holdings in the study region. The study findings indicated that not all economically valued restoration outputs contribute to conservation area community incomes. The present net benefit from the study area generated an income of USD 158, which is almost half the national per capita income during the study. After the restoration outputs yielded maximum, net benefit expected from this study area increased incomes of beneficiaries six times more. Whereas restoring all the communal land in the study area would increase incomes to USD 4,526, which is way over what the government aims to achieve with its acclaimed 2025 Growth and Transformation Plan. However, to realize this it will require thorough research for the development of markets for different bio–geographic zones and evolving appropriate working plan prescriptions. Moreover, the possibilities of linking these services to international protocols in conservation of natural resources, global warming, and world trade have to be explored.
Adaptation Research in Semi Arid Regions of South Asia

S. Gajjar (1)
(1) Indian Institute for Human Settlements, Environment and Climate, Bangalore, India

Faced with high climate variability and a multitude of development challenges, people in the semi-arid regions of Africa and Asia are particularly vulnerable to climate-related risks. Interventions to date have focused mainly on short-term solutions, leaving large gaps in our understanding of which responses will enable widespread, effective and sustained adaptation over longer time horizons.

The Adaptation at Scale in Semi–Arid Regions (ASSAR) project aims to fill the above knowledge gap. Central to the ASSAR project is a focus on multi-stakeholder processes, which help in identifying key adaptation and development-related vulnerabilities, and determining responses that can yield tangible and lasting benefits to society.

Key insights are emerging from South Asia’s multi-institutional team’s research and interaction with a range of stakeholders. Over the past year, policy makers, senior government officials, farmers, community members, academics as well as practitioners were engaged through a variety of formats including key informant interviews, participatory workshops and research validation events.

Initial research findings suggest that the welfare cost of climate change impacts in India varies across geographies and sectors. Given the high prevalence of natural resource based livelihoods, high incidence of poverty and inherent socio-economic inequalities, a significant section of the population is ill-equipped to adapt to current and projected climate variability. While households dependent on agriculture are directly affected, those living in urban areas are also affected by declining agricultural productivity. At the same time, rapid and largely unplanned urbanization manifests in an intense competition for resources and land. Quality of life for marginalized groups in urban areas is characterized by lack of access to social capital, poor quality of jobs and exclusion from public services. This begs the question whether migration for livelihood and landscape changes during the 20th century. The project is multidisciplinary and is using an historical frame of a cooperation with IRD aimed to reconstruct the climate and landscape changes during the 20th century. The project generates valuable lessons for future research initiatives aspiring to contribute to climate change adaptation.
O-2222-03

Adaptive Capacity and Risk management: Evidence from household-level data from semi-arid tropical villages in India

A. Rahman (1) ; C. Singh (2) ; P. Mudliar (3)

(1) Indian Institute for Human Settlements, Bangalore, India; (2) Indian Institute of Human Settlements, Bangalore, India; (3) iih, Bangalore, India

Objective

This paper attempts to provide evidence on how households respond to climatic variability and extreme events, such as droughts and floods in the semi-arid regions of India. It looks at how vulnerabilities inherent in farming households and the risks faced by them, which shape and affect local adaptive capacity. Two key questions which this paper would address are – the impact of climate change on food production and the extent of climate induced migration. The paper focuses on semi-arid regions since this region is highly vulnerable to climate change, to several socio-economic risks apart from rainfall-related production risk.

Background

Semi-arid regions constitute almost 53 percent of India’s land cover, where agriculture is the primary source of livelihood. In addition to being drought-prone and being vulnerable to rainfall-related production risks, semi-arid regions are characterized by higher levels of poverty, poorer asset ownership, higher indebtedness, smaller land holdings, and lower levels of land productivity. Poor performance of agriculture and lack of other livelihood options further limit their capacities to anticipate and respond to climatic variability.

Data

Household level panel data for 17 villages in India has been collected by the International Crops Research Institute for Semi-Arid Tropics (ICRISAT) which is used for the analysis here. This is a unique dataset in the sense that it provides an opportunity to track the economic status of households over time along with the information whether they faced droughts/floods during the period and the response adopted by them.

Relevance of the Research

This research would enable a deeper understanding of the conditions under which household vulnerabilities in semi-arid regions are shaped. It has direct implications for their current and future ability to adapt to climate change. The uniqueness of the data helps us identify which households are vulnerable to climate change, measure the impact of climate change on household assets and production patterns, and measure adaptation responses to climate-related risks. In a nutshell, this paper aims to answer questions related to vulnerability, impacts and adaptability within the context of climate change in semi-arid villages in India.

O-2222-04

Tropical warm semi-arid regions expanding over temperate latitudes in the projected next century

A. Rajaud (1) ; N. De Noblet-Ducoudré (2)

(1) Laboratoire des Sciences du Climat et de l’environnement, Gif-sur-Yvette cédex, France; (2) Laboratoire des Sciences du Climat et de l’environnement, CEA-CNRS-UVSQ, Gif-sur-Yvette cédex, France

Two billion people today live in so-called dry lands (Millennium Ecosystem Assessment, 2005), where extreme climatic conditions prevail, and natural resources are limited. The future of those drylands is therefore challenging for many human beings. Drylands are expected to expand under several scenarios of climatic change (e.g. Feng and Fu, Atmos. Chem. Phys, 2013). However, the actual tropical belt towards the north pole. This poleward migration is of ~+11°, 7° and 10° respectively for RCP2.6 and RCP8.5 (multi-model mean). This will be most significant outside the actual tropical belt towards the North Pole. This poleward migration is of ~+11°, 7° and 10° respectively for RCP2.6, 4.5, and 8.5.

Two processes mainly explain this expansion: warming and drying. Drying is mostly responsible for the conversion from equatorial, subhumid climates within the tropical belt. Beyond 30° of latitude, warming is directly responsible for the conversion of cold semi-arid to warm semi-arid climates. The reason is the poleward migration of the warm semi-arid class, characterized by a mean annual temperature exceeding 18°C and water-limitation criteria calculated from the seasonal distribution of rainfall and temperature.

Maladaptation is a concept that has received notable policy attention in recent years, but has yet to be fully explored in both conceptual and practical terms. As a consequence it suffers from a lack of consensus on its definition and application in policy and programming. While there is general agreement that maladaptation involves action to address climate change but increases vulnerabilities or reduces adaptive capacity, there is disagreement over what causes such action.

One of the reasons why maladaptation is such a powerful term is that it encourages practitioners and policy-makers to recognise that the decisions they take now to address climate change can backfire and inadvertently make people more vulnerable in the longer term. However, a lack of consensus and clarity on how to characterise maladaptation currently prevents decision makers from...
being able to apply the concept in practice.

In the context of semi-arid regions, the immediacy of many development challenges, the susceptibility of these areas to existing climate variability and the inherent non-linearity versus variability of systems contribute to a higher risk of maladaptive outcomes arising from development or adaptation strategies.

We outline five areas of conceptual clarity needed in understanding and evaluating maladaptation in semi-arid regions and elsewhere.

First, deliberate non-action should, if contributing to increased climate risks and negative outcomes for people and communities, be considered as maladaptation. The semi-arid regions of Africa, for example, have long been actively marginalised from the economy and politics. Over the past decades, a lack of development in these regions over long periods has contributed to high levels of vulnerability.

Second, a strategy that has not considered the impacts of climate change should constitute maladaptation. For example, many pastoralist communities have been encouraged to diversify livelihoods as a result of persistent drought. But moving away from semi-nomadic pastoralism can erode existing adaptive capacity, leading to greater vulnerability.

Third, a fundamental component of maladaptation is time. It is only with time that the success or failure of interventions will become evident. This trait is well illustrated in the context of groundwater abstraction for adaptation in semi-arid regions, which may be maladaptive in the longer term.

Fourth, semi-arid ecosystems, livelihoods and economies are not static. Moreover, under climate change, climate risks and vulnerabilities to particular climate variables are likely to shift. Semi-arid systems are characterised by non-linear and unpredictable dynamics in both their socio-economic and ecological components.

Fifth, distributional aspects of adaptation are important because climate change is likely to affect segments of the population differently, both in terms of direct impacts as well as influences on wider drivers of development, and the act of implementing (or choosing not to implement) an adaptation strategy can fail to uniformly reduce climate risks across all social groups. For example, strategies to enhance and diversify livelihoods for adaptation to climate change and variability can reinforce inequalities in terms of gender, or livelihood types.

Building on this reconceptualisation of maladaptation, we present the groundwork for a framework that can lend itself to qualitative and quantitative assessment of adaptation strategies, and clarify the differences between four distinct types of adaptation outcomes – ranging from optimal adaptation to maladaptation. Most importantly, we have used the framework to highlight a number of different ‘symptoms’ that can act as early warnings for maladaptive outcomes, hoping to guide policy makers in being able to apply the concept in practice.

We discuss these weaknesses in the methods while applying the conventional indicator approach to an empirical case in semi-arid Karnataka. We compared the effectiveness and usability of indicators to study structural drivers of vulnerability. Household and community scale analysis was carried out in semi-arid region of Karnataka. The agrarian based livelihood in this area is largely dependent on ground water resources. We used adapted versions of three indicator based vulnerability assessments: Livelihood Vulnerability Index (LVI), LVI IPCC and the Livelihood Effect Index (LEI). These methods highlighted the need for showing drivers of vulnerability of farming communities in this region.

The purpose of this paper is to develop agricultural and water management strategies to help poor traditional rain fed farmers to adapt climate change impact on agriculture in North Kordofan region in Sudan. Historic climate data from the study area were collected and analyzed using CROPWAT model. Model simulations also highlighted the vulnerability of traditional rain fed farmers to adapt climate change impact on agriculture in North Kordofan. This research study is considered the first to develop agricultural and water management strategies to cope with climate change impact on traditional rain fed agriculture in North Kordofan, Sudan. It also highlights that farmers are making to adjust to the changes they observe.

**P-2222-02**

Understanding agricultural vulnerability: An approach to identify and understand vulnerability of an agrarian based livelihood system in a watershed area

S. Divya (1); S. Badiger (2); J. Krishnaswamy (2)

(1) ATREE, Livelihoods, Bangalore, Karnataka, India; (2) Ashoka Trust for Research in Ecology and the Environment, Bangalore, India

Epistemological understanding of vulnerability and its assessment methods follow two main schools of thought: (1) the ‘contextual vulnerability’ (whereby adaptive capacity or resilience is seen as an inherent characteristic of the system and its components, or the number in which the system reacts to external stressors; and (2) the ‘outcome vulnerability’, where the primary focus is on the impacts of a hazard (which is a process in itself driven by some other primary driver). Indicator based vulnerability assessments have gained increasing importance in the last decade, particularly within dominant framing of the climate change along with other structural variables. Within this methodology, indicators are used as proxies in order to quantify components contributing to vulnerability. This is done at either household or community level, or both essentially depending on its intent to identify points of interventions. The primary weaknesses of these methods are in arriving at meaningful weights for the sub-components and the indicators. The assumption of direct causal linkages between indicators and vulnerability is another pertinent factor in these methodologies.

We discuss these weaknesses in the methods while applying the conventional indicator approach to an empirical case in semi-arid Karnataka. We compared the effectiveness and usability of indicators to study structural drivers of vulnerability. Household and community scale analysis was carried out in semi-arid region of Karnataka. The agrarian based livelihood in this area is largely dependent on ground water resources. We used adapted versions of three indicator based vulnerability assessments: Livelihood Vulnerability Index (LVI), LVI IPCC and the Livelihood Effect Index (LEI). These methods highlighted the need for showing drivers of vulnerability of farming communities in this region.

Results indicated that financial sub-components were the largest contributor to both household and community level vulnerability. The LVI–IPCC method indicated that exposure to climatic events was greater than the adaptive capacity and this significantly contributed to vulnerability of the community. Results from the LEI, suggests that individual households in this area will be more affected by climate change than communities.

This study demonstrated the inability of indicator-based methodologies to represent intricate ground realities, which indexes tend to over simplify. Assumptions of linear two dimensional relationships can inaccurately attribute vulnerability to a particular causal factor. Moreover, these methodologies largely ignore the requirement of minimum threshold capitals that determine the functioning state of a system. Based on the results and analysis of this study we suggest a framework for developing methodologies for vulnerability assessment suitable for a particular agro
climatic zone. In this framework vulnerability is treated as a dynamic concept moderated by socio-economic, political processes and human–environment relationships. The framework incorporates the concept of minimum thresholds in the capitals, a concept widely used in Law of Minimization (von Liebig, 1840), which posits that there are capitals that govern the state of a system and growth is determined by the scarce resource required by the system. We suggest that there are certain key characteristics, in particular to a specific agro-climatic zone that defines the vulnerability of the system. This framework is aimed at providing a pragmatic methodology for comparison of vulnerability across regions in similar agro-climatic zones. The framework attempts to map the impacts of coping and adaptive strategies on components of a socio-ecological system, through analysis of drivers and enablers of vulnerability within a particular spatial scale, and the establishment of a vulnerability framework. This framework can contribute towards developing appropriate policy intervention strategies to facilitate adaptation processes for particular agro-climatic zones.

P-2222-03

Studies of Long Term Changes in Climate and Environment in South-East Georgia – A Key for Sustainable Development

M. Elashvili (1) ; K. Kviledzide (2) ; L. Navrozashvili (2) ; L. Sukhishvili (2)
(1) Iulia State University, School of Natural Sciences and Engineering, Tbilisi, Georgia; (2) Iulia State University, Tbilisi, Georgia

Recognizing the fact that we are living in a constantly changing world became actual during the last decades, and scientific and public concern increased. The understanding of climate change and human impact. In this sense, study of past changes in environment and, its effect on human society coupled with better understanding of current changes in the environment delivers key information to project future changes and their effect.

South-East Georgia represents natural polygon of long term changes in the environment to be caused by combination of natural and anthropogenic factors. In the convention adopted by UN in 1994 on 12th of September – A/AC.241/27, among the regions which are under the risk of desertification and drought Trans Caucasus is also mentioned. On the map developed in 1998 by natural resources and conservation service of US Department of Agriculture Iori upland is situated in the area of moderate, high and very high risk. The southward part of the area in South-East Georgia are characterized with annual precipitation <600mm and shows open steppic landscape today. However archaeological studies deliver evidences of well-developed bronze and early iron age settlements in the areas almost devoid of water sources today. Archaeo-Botanic studies also assume that the region was covered by forests instead of steppes.

The goal of current study is: to shed light on historic changes in the environment of the region, its natural and anthropogenic factors and consequently response of human society on these changes; to assess rate and scale of ongoing desertification process during the past decades; to project future possible changes in the environment and based on past experience elaborate adaptation and mitigation policy.

The proposed investigation is focused on identifying the source of modern changes to the environment in South–East Georgia and to discern the relationships of this environmental change to current and past actions of the human population. Long-term, sub-regional records of these changes will be constructed in terms of: 1) physical changes of vegetation; 2) changing patterns of land use/land cover, and settlement; and 3) changing aspects of land quality in relation to agriculture.

Climate change is a serious challenge to sustainable development. Historically, study of desertification, as one of the main consequences of climate change coupled with anthropogenic stress, can provide valuable materials for understanding the mechanisms of climate change. Research and understanding of meteorological patterns are very important in order to come up with the solutions for sustainable development; therefore the present research (project) will ultimately contribute to developing long term mitigation and resilient strategies and policies for sustainable development of the region.
the Lake Chad basin. The recent IPCC– AR5 report has concluded that the rainfall trends should be moderated over the Chari basin, but with a great uncertainty and no clear indication on the direction of the change. In the short term and as a first step, the ongoing and projected LCBC basin wide programmes aiming at increasing agricultural water productivity and resilience to climate change may be usefully developed and increased.

P-2222-06
The role of cactus pear (Opuntia ficus-indica (L. Mill)) in the conservation of water and soil in the Shkour Rhamna drylands (Province of Rhamna, Morocco)
M. Mejatii Alami (1); M. Chikhaoui (1); & S. Kanga (1)
(1) IAV Hassan II, Natural Resources and Environment, Rabat, Morocco
Seasonal and annual fluctuations in rainfall, and drought, are quite common phenomena in arid lands of Morocco. In addition to anthropogenic activities, these phenomena generate soil erosion, which in turn cause desertification.

The conservation of soil and water in these environments relies on adaptive measures, which are necessary to rehabilitate and prevent soil erosion. Therefore, the choice of drought resistant species and the ones having low demands on edaphic conditions is required. In this regard, cactus (Opuntia ficus-indica), can be one of the best choices.

This work was carried out in the rural town of Shkour-Rhamna, an arid area of the province of Rhamna in southern Morocco. We aim to evaluate the effect of planting cactus on the conservation of water and soil. Therefore, we set to study the effects of cactus plantations on the physicochemical properties of soil and vegetation. We used a comparative approach holding cactus plantation in plots with different ages and planting densities and a control plot without cactus planting. For experimental plots were selected, one with plantation of 3 years of age having a density of 5000 plants / ha, and an older one (6 years) with a planting density of 6700 plants / ha.

We collected soil samples from each plot at different depths, which then were analyzed for organic matter and particle size determination. In parallel, we measured the infiltration rate. We also assessed the vegetation parameters such as the plant cover, the species diversity and abundance.

The results showed that planting cactus has a statistically significant effect on the organic matter content and the plant cover. Plots under cactus plantations showed the best water infiltration rates. So planting cactus in arid zones could conserve soil by reducing runoff and minimizing soil loss by erosion.

P-2222-07
Analysis of Rainfall Characteristics Relevant to Agricultural Planning in Narok County, Kenya
E. Mutuma (1); E. Micheli (2); S. Murimi (3); & V. Land (2)
(1) Kenya Agricultural Research and Livestock Organization, soil and water, NAIROB-KENYA; (2) Soil and Water Science, University of Trondheim; (3) Kenyatta University, Soil science and agricultural chemistry, Gulu, Uganda; (4) University of Trento, Department of Geology and Geography, Nairobi, Kenya

Climatic factors play an important role in determining the production of food crops in the semi-arid regions of Africa. This is a region characterized by a low and highly variable distribution of rainfall spatially and over time, which institutes a limiting potential for crop yields. Both short and long rainy periods experience dry spells that substantially influence agriculture. There are also spells where rainfall is excessive in these regions resulting in floods and excessive erosion. Understanding of the behaviour of the wet and dry spells could improve management of the agricultural activities by farmers. The objectives of this study were explore the characteristics of annual and seasonal rainfall and to simulate stochastically the dry and wet spells using Markov models. In–depth interviews were conducted with 120 small–scale farmers to establish what constitutes agriculturally relevant rainfall characteristics for small–scale farmers. Farmers’ perceptions reflected seasonality, distribution and intensity. Half of the respondents felt there had been a change in seasonality. Ninety percent of the respondents’ claimed that the amount of rain throughout the first season had decreased with 98% of the respondents having the same sentiments for the second season. A significance test that there is no change in annual rainfall over time resulted in a t-value of 1.703. The significance level of this t–test is 0.3044; hence there was no statistically significant change in annual rainfall within the study period. The number of days of rainfall shows a significant decrease within the study period for both long and short rain seasons. The risk of suffering losses when crops that are sensitive to dry spells of up to 10 days are planted in March 1st is therefore more than 75 percent. Long dry spells at sensitive times of plant development (germination, flowering, seeding) could spell disaster for farmers. The risk of dry spells after planting had increased over the decades making farming for small–scale agriculturalists even more risky. The findings of the study suggests the need for the development of a comprehensive agricultural and climate change and variability policy that takes into account the mounting risks associated with agricultural production among small holder farmers.

P-2222-08
The impact of Climate change to agricultural production of the coastal to reservoirs areas and creation of adaptation mechanisms
P. Normatov (1)
(1) Tajik National University, Meteorology and Climatology, Dushanbe, Tajikistan

The food products manufacture in Tajikistan already faces many serious difficulties caused mainly prompt growth of the population, mountain topography, limitation of farmlands accessible to grain crops and livestock because of abrupt inclinations both high eminences and improper microclimates. The average monthly change in the second half of the century on the person makes 0.14 ha/person who at comparison with global average 0.26 ha/person is low enough.

Researches of dynamics of change of climatic parameters in three agricultural areas adjoining to the Nurek reservoir in Tajikistan have shown that the mid–annual temperature for 20 years (1968–2000) has raised 1.0–1.5 °C that has led to decrease in relative humidity on 3–6 % and to increase potential evaporation on 10–26 % in annually. For example, in the Yavan valley of the Republic of Tajikistan recommended irrigation regimes are connected with the overexpenditure of water resources. Long dry spells and climate change conditions on irrigation modes to take the Yavan valley on mean annual value of humidity (0.35) to the category of droughty areas. But as show the obtained data, for last 20 years evaporation in a valley has decreased almost on 300 mm (17 %) and the amount of precipitation has risen on 70 mm (11 %). As a result, value of humidity has risen to 0.45. Hence present irrigating norms for cultivation of cotton in the Yavan valley -1 100 m³/ha and for a Lucerne are overestimated. Calculations show that unproductive losses of water only on two valleys make more than 60 Min.m³.

In present paper results of researches on creation scientifically reasonable the scenario and recommendations for cultivation of crops with high value of efficiency and stability against climate change. As a result of researches the increase in efficiency of units of irrigation water and the irrigated lands are presented.

P-2222-09
Strategies of sustainability, green building and climate change in Brazil
J. Rezende (1)
(1) Universidade Federal do Rio Grande do Norte – UFRN, Industrial Engineering, Natal – RN, Brazil

The project Strategies of sustainability, green building and climate change in Brazil: diagnose and provide the development of sustainability strategies of coexistence with the climate change in Brazil.
In Brazil, the project Strategies of sustainability and climate change in South Africa and Brazil will be operationalized in
ABSTRACT BOOK

Philosophy was based on an opening to absorb various implications of researching the recycling and reuse of pet bottles. Polyethylene terephthalate is a thermoplastic polymer that takes the environment about 400 years to degrade. The project Sustainability Strategies and Climate Change in Brazil is characterized by the following pillars: 1 - Construction and sustainable energy; 2 - Waste management; 3 - Preservation of biodiversity and the ecosystem; 4 - Water resources management; 5 - Education, involvement of child and youth in cultural, creative, environmental, social, inclusive and participatory activities; 6 - Formulation and participation in public policies; 7 - Self / Empowerment / Entrepreneurship; 8 - Tourism; 9 - Agriculture; and 10 - Cultural and Historical rescue and cultural economy.

Intervention activities was also important to the culture and the development of the cultural economy (music, art, crafts, dance, festivities), also important to sustainability strategies developed in order to deal with climate warming. The project will provide the realization of sustainable buildings in the communities served, as well as the transfer of knowledge to local staff, as well as the construction of a collective knowledge of other sustainability strategies that can be developed for better association with global warming.

It stands out on the farm the adoption of a sustainable management model, a kind of sustainability philosophy was very important to rural properties. The management philosophy was based on an opening to absorb various learnings and openness to volunteering.

The project incorporates waste management mechanisms to provide communities, municipalities, organisations and businesses regarding the type of sustainability management models to implement and explore innovative methods to improve the relationship with climate change.

Since the new government's ascent into power in India, there has been an increase in investment by the government, the private sector, and foreign investors to develop 100 smart cities in India. The idea of smart cities has been greeted in India with an equal measure of hype and skepticism. Although there is still no clear consensus on what a smart city means, it is generally agreed that "smart" refers to using technology to solve urban problems. In a country that still lacks basic housing, water, and energy infrastructure, as well as access to health and education services, there is much debate about whether smart cities will be able to address these pressing issues. Moreover, apart from a draft concept note, India lacks a national policy on smart cities. The recent budget avoided the term 'smart city', allocating funds to the Delhi-Mumbai corridor and Gujarat International Finance Tec-City (GIFT), India's first smart city, instead. In the absence of a well-defined policy, there are concerns over how the $1.2 billion will be used to develop local, rural, and urban sustainability projects and how it will mainstream climate risk management. It is also unclear how cities in already stressed environments such as in semi-arid regions, will evolve to negotiate development and climate risk management goals.

In rural landscapes, agriculture is constrained by various non-climatic dynamics such as deteriorating soil fertility, depleting ground water levels, and global price fluctuations, and migration towards urban centres. Increasing climatic variability and projected climate change, especially in resource-constrained areas such as semi-arid regions in India, are expected to interact with existing vulnerabilities, exacerbating them and potentially making agriculture an unsustainable livelihood. To address this growing concern, climate smart agriculture (CSA) has emerged as a strategy for developing mitigation and adaptation strategies that can help make agriculture and agricultural livelihoods more resilient to climatic changes. In 2011, the Government of India set up the National Institute for Climate Resilient Agriculture (NICRA) with a budgetary allocation of $64.81 million. With a core mandate of long-term strategic research on the impacts of projected climate change on Indian agriculture and demonstration, it focuses on developing 'smart' policies to help farmers cope with current climate variability, NICRA is a crucial actor in India's CSA discourse.

In light of these developments, this paper traces the evolution of the smart policy discourse in India by examining the evolution of smart cities in urban areas and CSA in rural areas as well as the key actors and organizations shaping these discourses. By doing so, we contribute to the larger smart city discourse that has begun to shun the term 'smart city' and questions whether it has become a term that has reached the end of its usefulness. We also argue that while CSA forefronts vulnerability to climate change, it potentially obscures larger development issues and inherent vulnerabilities. This is also the danger of old wine in a new bottle, where existing agroecological techniques that have been practised by farmers traditionally, are being repackaged to make their livelihoods 'smart'. While the investment such a discursive shift attracts is useful, we argue that it is important to understand how such policy trajectories create winners and losers.

In conclusion, while the term smart invokes a variety of desirable visions of a utopia where technology is used to operate infrastructure achieving efficiency and sustainability, we argue that it is important to question whether "smart" policies are the answer to problems of living and livelihoods more resilient to current and future climatic risks.

P-2222-10
Are Smart Policies Really Smart? Analyzing the Implications of Smart Policies on Risk Management in India
C. Singh (1); P. Mudliar (1); A. Rahman (1)
(1) Indian Institute for Human Settlements, Bangalore, India
Semi-arid regions, such as the African Sahel, are typically located in the boundary between extremely dry (e.g. arid) and much wetter (e.g. humid subtropical) climate zones. The semi-arid regions of Africa and South Asia are subject to high- and low-frequency rainfall variability and people living in these regions are particularly exposed to the impacts of rainfall variability and climate change. The success of the semi-arid regions in living with the environment and sustaining their livelihoods has significant consequences for how people in semi-arid regions live with the environment and sustain their livelihoods.

The Adaptation at Scale in Semi-Arid Regions (ASSAR) project is one of four projects being funded through the Collaborative Adaptation Research Initiative in Africa and Asia (CARIAA). We will present the latest evidence and understanding of climate–related variability and trends, in the semi-arid regions of Africa and South Asia, gathered by scientists working in the Climate and Biophysical Impact (CBI) team of ASSAR. In general, the weight of evidence suggests that climate change is having largely adverse effects on natural systems supporting people’s livelihoods. The regional climate risk models for Africa and South Asia. Temperatures in these regions are rising at above global average rates and in some locations this is leading to measurable impacts on human and natural systems. However, significant year-to-year and longer-term variability in rainfall patterns means that any attribution of rainfall trends to global climate change is complicated. Also, future projections show large disagreements in the direction of rainfall changes and climate models are subject to large uncertainties that complicate any interpretation of climate messages. Ultimately the impacts of climate change on human and biophysical systems will manifest themselves through the combined effect of changes in temperature, rainfall, humidity and other climate–related variables. Moreover, it is only by understanding specific system sensitivities and adaptive capacities that useful information can be derived to support adaptation research and practice. Examples of how climate variability and change is impacting socio–ecological systems in semi–arid regions of Africa and south Asia will be provided.

The CBI team is made up of climate scientists, crop modellers, hydrologists, ecologists and social scientists. In the first year of the project the team developed a series of “Regional Climate Messages” documents that were produced for the four regions under investigation, namely Southern Africa, East Africa, West Africa and India. The documents provide adaptation and future climate aimed at informing policymakers, practitioners and researchers working in these regions – key results will be shared. In addition, the team is continuing to work alongside colleagues in the ASSAR project to provide tailored information that can directly feed into the adaptation–focused research. Ultimately the wider ASSAR project research aims to both generate transferable knowledge related to issues of adaptation across multiple scales of governance and to develop transformative scenarios that influence adaptation and development planning in the focus regions.

Crop supplemental irrigation experiences in Burkina Faso

B. Zongo (1); D. Abdoulaye, (2); B. Barbier (3); D. Thomas, (4)

(1) International Institute for Water and Environmental Engineering (2IE), Ouagadougou, Burkina Faso; (2) International Institute for Water and Environmental Engineering (2IE), Laboratory d’Hydraulique et des ressources en eau, Ouagadougou, Burkina Faso; (3) CIRAD, UMR geau, Dakar, Senegal; (4) Université de Liège, Department of rural economic and development, Gembloux, Belgium

This study assesses the impact of supplemental irrigation from small man–made basins on cereal production in semi-arid regions, the degradation of natural resources in arid and semi-arid regions, such as the African Sahel, are typically located in the boundary between extremely dry (e.g. arid) and much wetter (e.g. humid subtropical) climate zones. The semi-arid regions of Africa and South Asia are subject to high- and low-frequency rainfall variability and people living in these regions are particularly exposed to the impacts of rainfall variability and climate change. The success of the semi-arid regions in living with the environment and sustaining their livelihoods has significant consequences for how people in semi-arid regions live with the environment and sustain their livelihoods.

The Agricultural Model Intercomparison and Improvement Project (AgMIP) is a major international effort linking the climate, crop, and economic modeling communities with cutting-edge information technology to produce improved crop and economic models and the next generation of climate impact projections for the agricultural sector.

The Agricultural Model Intercomparison and Improvement Project (AgMIP) is a major international effort linking the climate, crop, and economic modeling communities with cutting-edge information technology to produce improved crop and economic models and the next generation of climate impact projections for the agricultural sector.

The Agricultural Model Intercomparison and Improvement Project (AgMIP) is a major international effort linking the climate, crop, and economic modeling communities with cutting-edge information technology to produce improved crop and economic models and the next generation of climate impact projections for the agricultural sector.

The Agricultural Model Intercomparison and Improvement Project (AgMIP) is a major international effort linking the climate, crop, and economic modeling communities with cutting-edge information technology to produce improved crop and economic models and the next generation of climate impact projections for the agricultural sector.

Oral Presentations

K-2223-01

The Agricultural Model Intercomparison and Improvement Project: Transdisciplinary and Multi-scale Agricultural Projections of Climate Change Impacts

C. Rosenzweig (1)
(1) NASA Goddard Institute for Space Studies, New York, United States of America

The Agricultural Model Intercomparison and Improvement Project (AgMIP) is a major international effort linking the climate, crop, and economic modeling communities with cutting-edge information technology to produce improved crop and economic models and the next generation of climate impact projections for the agricultural sector.
Currently, AgMIP has over 700 participants from more than 95 countries, containing their expertise to over 30 projects and activities. The goals of AgMIP are to improve substantially the characterization of world food security due to climate change and to enhance adaptation capacity in both developing and developed countries.

Since 2010, AgMIP has engaged stakeholders and researchers to assess climate impacts on food security and plan for a more resilient future. AgMIP has built a cutting-edge assessment framework on both global and regional scales, which links climate, crops, livestock, and economics to help decision-makers better understand how climate change will reverberate through complex agricultural systems and markets.

AgMIP initiatives include regional integrated assessments, global economic assessments and global crop modeling activities, data and tools to facilitate multi-model and multi-discipline assessments, and cross-cutting themes to help interpret agricultural model results for decision makers. For instance, improvements and extensions to the Intergovernmental Panel on Climate Change Fifth Assessment Report, provide important context for national and regional stakeholders interpreting climate change risks, further state-of-the-art global food security assessments and agricultural models, and deliver key inputs, such as commodity prices, into regional integrated assessments.

AgMIP is now planning a coordinated global and regional assessment of future food security under changing climate.

K-2223-02

Projecting grassland sensitivity to climate change from an ensemble of models

JF. Soussana (1); F. Erhhardt (1); R. Conant (2); M. Harrison (3); M. Lieffering (4); G. Bellocchi (5); A. Moore (6); S. Rolinski (7); V. Snow (8); L. Wu (9); A. Ruane (10)

(1) Inra, Paris, France; (2) NREL, Colorado State University, Fort Collins, CO, United States of America; (3) Tasmanian institute of Agriculture, Burnie, Australia; (4) AgResearch Grasslands, Palmerston North, New Zealand; (5) Inra, Grassland ecosystem research, Clermont-Ferrand, France; (6) CSIRO, Canberra, Australia; (7) Potsdam Institute for Climate Impact Research, Potsdam, Germany; (8) AgResearch, Christchurch, New Zealand; (9) Rothamsted Research, Harpenden, United Kingdom; (10) NASA Goddard Institute for Space Studies, Climate Impacts Group, New York, NY, United States of America

The grassland biome covers about one-quarter of the earth’s land area and contributes to the livelihoods of ca. 800 million people. Increased aridity and persistent droughts are projected in the twenty-first century for most of Africa, southern Europe and the Middle East, most of the Americas, Australia and South East Asia. A number of these regions have a large fraction of their land use covered by grasslands and rangelands. Grasslands are the ecosystems that respond most rapidly to precipitation variability. However, global projections of climate change impacts on grasslands are still lacking in the scientific literature. Within AgMIP, based on the C3MP protocol initially developed for crops, we have explored the sensitivity of temperate grasslands to climate change drivers with an ensemble of models. Site calibrated models are used to provide projections under probabilistic climate change scenarios, which are then analyzed as a combination of temperature, precipitation and atmospheric CO2 changes resulting in 99 runs for each model times site combination. This design provides a test of grassland production, GHG (N2O and CH4) emissions and soil carbon sensitivity to climate change drivers. This integrated approach has been tested for 12 grassland simulation models applied to 19 sites over three continents. We show here that a single polynomial emulator can be fitted with high significance to the results of all models and sites, when these are expressed as relative changes from the optimal combination of climate drivers. This polynomial emulator shows that elevated atmospheric CO2 expands the thermal and hydric range which allows for the development of temperate grasslands. Moreover, we calculate the climatic response surface of GHG emissions per unit grassland production and we show that for most sites, we observe large changes from these results we provide first estimates of the impacts of climate change on temperate grasslands based on a range of climate scenarios.

K-2223-03

Impacts and implications of global and regional climate change for agriculture

C. Müller (1); J. Elliott (2)

(1) Potsdam Institute for Climate Impact Research, Potsdam, Germany; (2) University of Chicago and Argonne National Laboratory Computation Institute, Chicago, United States of America

Agriculture faces severe challenges from increasing demands for food, fiber and biofuels, a need to decrease its environmental burden and to build resilience against climate change impacts. While impacts and adaptation measures need to be assessed and understood at both local and global scales, the interconnections and societal implications can only be understood at regional to global scales analyses. The Agricultural Model Intercomparison and Improvement Project (AgMIP) and the Intersectoral Impact Model Intercomparison (ISI-MIP) have conducted comprehensive global-scale assessments of climate change impacts on agricultural productivity and related sectors (e.g. water, markets) that allow for understanding the scope of the climate challenge for agriculture and food security, including an assessment of associated uncertainties. Climate change under the RCP8.5 emission scenario has the potential to reduce global crop productivity in the range of 24 to 43%, which may be amended by positive effects of carbon dioxide fertilization to losses of 8 to 24%. Climate-driven reductions in availability of irrigation water could lead to a loss of 20-60% of irrigated area. Adaptation responses in land-use patterns, trade and consumption are able to compensate for climate-driven impacts but lead to higher food prices (20% on average). Challenges that need to be addressed at the global scale are the increasing disparity between high- and low productivity countries, which often reflects the disparity in development. Also, increasing variability under climate change is a robust finding across the board of scenarios and will require adequate measures to avoid devastating effects, especially for the poor.

O-2223-01

FACE MACSUr: Modelling Agriculture with Climate Change for Food Security

M. Köchly (1); M. Banse (1); R. Tiffin (2); F. Ewert (3); N. Scollen (4); F. Brouwer (5); R. Rötter (6); A. Bannink (7); F. Sinabell (8)

(1) Thünen Institute, Market analysis, Braunschweig, Germany; (2) University of Reading, Centre for food security, school of agriculture, policy, environment and development, United Kingdom; (3) University of Bonn, Institute of crop science and resource conservation, Bonn, Germany; (4) Aberystwyth University, Institute of biological, environmental and rural sciences, Aberystwyth, United Kingdom; (5) Wageningen UR, LEI, The Hague, Netherlands; (6) Luke, Natural Resources Institute Finland, Mikkeli, Finland; (7) Wageningen UR, Animal sciences group, Wageningen, Netherlands; (8) WIFO – Austrian Institute of Economic Research, Vienna, Austria

FACE MACSUr (http://macsur.eu) is a network of currently 270 scientists from 18 European and associated countries for improving the European capacity of modelling the effects of climate change and socio-economic changes on agriculture. This concerns crop and grassland production, livestock, crop production, farm management, related to adaptation and mitigation measures, and development of price relations on national to global markets. The emphasis is on the linking of models and data across scientific disciplines. We will make use of the developments of the network. Collaborative efforts in the network include the advancement of modelling methodologies, agreement on common modelling scenarios for joint evaluation, comparison and benchmarking of models. These new research projects, organization of training courses and workshops, and interactions with decision-makers, farmers, and other stakeholders. MACSUr collaborates internationally with other networks, and many members are engaged in many other international projects and networks.

In the field of crop modelling, MACSUr has set-up and performed a comprehensive, unique model comparison study on simulating crop rotations using long term trial
data from various locations in Europe and looking at various output variables; also an inventory has been made on the available crop models and modelled cropping systems for Europe by the MACSUR CropM partners. MACSUR developed extensive databases on important ongoing modelling studies being carried out in Europe and it also embarked on developing a centralized system for data storage, distribution and visualization of model results. The knowledge hub systematically analysed scaling techniques, with a focus on climate and soil information for regional and (supra-) national climate change (CC) impact assessments and related uncertainties for a range of crop models. A large ensemble of 26 crop models has been used for a systematic climate sensitivity analysis based on impact response surface. New CC scenario data was developed for selected locations and regional case studies in Europe and use was made of agronomic impact of drought and the (multiple) risks to wheat production in the EU. Five PhD courses have been organized, dealing with various issues of generating data and applying modelling techniques for assessing CC impacts and adaptations to CC.

In the field of modelling of permanent grasslands, livestock and farms, the main focus across these diverse disciplines was to bring together specialists on a common subject. MACSUR established a performance comparison across several prominent models. Modelling of livestock productivity focused on the impacts of changing climatic conditions on animal health, productivity and feed and quality, and provided contributions to regional case study research. Datasets were identified relating to animal health and disease, and gaps in knowledge were explored at a broad level.

In socio-economic modelling, MACSUR focused on the soft linkage between crop production models and economic models at national and global levels and on comparisons of projections of crop price changes considering global trends in populations, politics, and climate.

Regional case studies constitute opportunities for linking models with less spatial heterogeneity and a longer tradition of model linkage across scientific disciplines. They also allow practitioners of modelled crop areas to discuss the impacts of climate change and discussing them with stakeholders. Our case studies in Finland, Austria, and Italy suggest that a simple climate envelope approach (moving production zones and non limiting water conditions and under ambient [CO2] to global scales) remains a challenge for the next two years. Furthermore, we will include more regional case studies and intensify our interactions with stakeholders.

**O-2223-02**

How accurately do crop models simulate the impact of CO2 atmospheric concentration on maize yield and water use?

J. L. Durand (1); K. Delusca (2); K. Boote (3); J. Lizaro (4); R. Manderscheid (5); C. Rosenberg (6); J. Jones (3); H. Weigel (5); A. Ruane (6)

(1) INRA, Environnement et Agronomie, Lusignan, France; (2) INRA, Lusignan, France; (3) University of Florida, Gainesville, Florida, United States of America; (4) ETSIA UPM, Madrid, Spain; (5) Johann Heinrich von Thunen Institute, Braunschweig, Germany; (6) NASA Goddard Institute for Space Studies, New York city, United States of America

Authors (continued): S. Anappali (6); L. Ahuja (7); B. Basso (7); C. Baron (8); P. Bertuzzi (9); D. Ripoche (9); C. Biernath (10); E. Deryng (11); F. Ewert (12); T. Gaiser (12); S. Gayer (12); F. Heilin (12); K. Kersebaum (13); SH. Kim (14); C. Muller (15); C. Nendel (16); J. Ramirez (17); F. Tao (18); D. Timlin (19); K. Waha (20); T. Twine (21); E. Wang (22); H. Webber (23); Z. Zhao (4); R. Rother (25); A. Srivastava (23); S. Seidel (26).
Exhibiting model elasticities to facilitate model intercomparison: an example with a simple land-use model

T. Brunelle (1)
(1) CIRED, Nogent-sur-Marne, France

In the coming decades, agriculture is projected to experience both demand and supply shocks originating from climate change, growing food needs or increasing demand for bioenergy. This specific context prompts the need for numerical assessments to anticipate the impact of climate change on crop yields. This is the case in several countries, including France, where a simple land-use model is used to evaluate the impact of climate change on agricultural productivity. The model is applied using data from a survey of over 9000 farmers administered as part of a Global Environment Facility (GEF) project in 11 African countries in 2003.

To get at the root of these discrepancies, this study applies a simple methodology to evaluate the impact of climate change on crop yields. We use a derived approach to evaluate the impact of climate change on crop yields. We use a derived approach to evaluate the impact of climate change on crop yields.
The agro-climatic index is one of the ways to assess the climate resources of particular agricultural areas on the prospect of agricultural production; it can be a key indicator of agricultural productivity by providing the basic information required for the implementation of different and various farming techniques and practicalities to estimate the growth and yield of crops from the climate resources (e.g., temperature, solar radiation, and precipitation). However, the distribution of agricultural climate resources varies depending on the climate change, and the agro-climate index can always be changed because there isn’t an accurate study which related the uncertainty of future climate change have been being actively conducted with multiple ensemble approach by developing and improving dynamic downscaling of climate information as well as statistical downscaling. RCP (representative concentration pathways) future scenarios of the Fifth Assessment Report of IPCC (intergovernmental panel on climate change) have been used in many recent studies. In this study, the agro-climatic index of Korean Peninsula, such as plant and crop period based on each base temperature, growing degree day, frost free day, and heating and cooling degree day were calculated for assessment of the indices’ temporal and spatial variations and uncertainties of the indices on climate change; the downscaled historical climate (1976–2005) and RCP future climate scenarios of AR4 (2011–2040) were applied to the calculation of the index. Additionally in the study, the assessments of the agro-climatic index and multi-model ensemble were considered for the practicability of the agricultural digital climate map of RDA (rural development administration).

The result showed each average of six agro-climatic indices of nine individual global climate models, as well as multi-model ensembles agreed with agro-climatic indices which were calculated by the observed data. It was confirmed that multi-model ensembles, as well as each eight individual global climate model, simulated well on past climate in the four major Rivers of South Korea (Han, Nakdong, Geum, and Yeongsan and Seumjin). The six agro-climatic indices of the Korean Peninsula were estimated by the observed data from individual global climate models and multi-model ensembles in future climate scenarios. However, spatial downscaling still needs further improvement since the agro-climatic indices of some individual global climate models, as well as multi-model ensembles agreed with agro-climatic indices which were calculated by the observed data. The differences and uncertainties of the agro-climatic indices have not been redressed and limited coupling of multi-model ensembles. Further research is still required; however, the differences started to improve when combining of three or four individual global climate models in the study. The agro-climatic indices which were calculated in the study will be the baseline for the assessment of agro-climatic abnormal indices and agro-productivity indices of the next research work. For example, if we assume that the temperature of winter will decrease in some areas of Nakdong, Yeongsan and Seumjin Rivers since frost free day has been estimated to increase in those regions in future climate projections, the assessment of frost free day of the regions will be able to take advantage of the assessment of the increasing uncertainty of agro-productivity of the winter crop or agricultural cropping system (e.g., double cropping system) by analyzing agro-climatic abnormal index (e.g., frequency of frost).
Climate change threatens global water and food security, especially in arid regions where water availability is already a critical limiting factor of agricultural productivity. Yet, increasing atmospheric carbon dioxide (CO2) concentrations are expected to raise rates of crop photosynthesis whilst also increasing the ratio of crop water use, or crop water productivity (CWp). The potentially large positive effects of rising CO2 on CWp will have major implications for increasing crop yields and reducing pressure on freshwater resources. However, to date there has been no systematic evaluation of global crop model simulation of CWp response to CO2 and climate change, and estimates of carbon fertilisation effects on crops based on observations continue to be controversial.

Our study addresses these gaps; by providing the first comprehensive global scale assessment of the combined effects of climate change and CO2 on global CWp using a large multi-model ensemble (originating from the Agricultural Modelling Intercomparison and Improvement Project (AgMIP), and by directly comparing model results with observations. Our modelling results suggest combined effects of climate change and CO2 are substantial, leading to increase in CWp by up to 13–27% globally (ensemble median, with a range of different crop types) by the 2080s relative to the 1980s. The range increases to 17–35% in water scarce arid regions. This suggests significant alleviation of negative effects of climate change on crop yield and pressure on water use in these areas.

Yet, a spread of CWp results are observed when considering climate and CO2 effects, reflecting uncertainty in modelling methodology and assumptions about CO2 response, which are large due to the lack of empirical observations globally. We show the spatial distribution in the impacts on four major crops critical for global food security: maize, wheat, rice and soybean. Our results indicate CO2 fertilisation effects play a key role in future agricultural productivity of food crops, management and emphasise the importance of extending experimental observation, especially in arid and semi-arid regions.

Our study addresses global scale modelling of an important dimension of agricultural production that is intimately connected with water resources. The effects of CO2 are shown to be large, key uncertainties are highlighted and mechanisms for future research are identified. These results demonstrate the need to diagnose further reasons for differences between crop model simulations of CWp and promote wider incorporation of CO2 effects in global food and water resource assessments.

Detecting the early stage of Phaeosphaeria leaf spot infestations in maize hybrid lines under different climate change scenarios using in situ hyperspectral data

A. Elhadi (1); H. Deng (2); J. Odini (3); E. Abdel-Rahman (3); O. Mutanga (3)

(1) University of The Witwatersrand, Johannesburg, School of Geography, Archaeology and Environmental Studies, Johannesburg, South Africa; (2) Institute of Aquatic Science and Technology (eaWaG), Dubendorf, Switzerland; (3) NASA Goddard Institute for Space Studies, New York, United States of America

Phaeosphaeria leaf spot (PLS) is considered as one of the major diseases that threat the stability of maize production in tropical and subtropical African regions. PLS is a foliar disease in maize caused by the ascomycete Phaeosphaeria maydis (Henn.), and has spread widely in areas of high rainfall and moderate temperatures. PLS can result in a considerable reduction in photosynthetic leaf area as well as crop yield, cause premature leaf drying thus reduce plant cycle and sharp decrease in grain size and weight and result in early plant death. The objective of the present study was to investigate the use of remote-sensing imagery in detecting the early stage PLS in tropical maize. Maize ground-based hyperspectral data were collected at the field level from healthy and early stage of PLS over two years (2013 and 2014) using a handheld spectroradiometer. Leave samples for full biochemical analysis were collected from the healthy leaves and early stage of PLS to test the impact of PLS on the maize plant physiology, of an integrated guided regularized random forest (GRRF) and traditional random forest (RF) was used for feature selection and classification respectively. The 2013 dataset was used to train the model, while the 2014 dataset was used as independent test dataset.

Results show that there were statistically significant differences in biochemical between the healthy leaves and early stage of PLS within certain biochemical variables such as nitrogen, phosphorus, calcium and magnesium. The new developed GRRF was able to reduce the high dimensionalities of hyperspectral wavelengths with less autocorrelation. These wavelengths are allocated at 420 nm, 795 nm, 779, 1543 nm, 1747 nm, and 1010 nm. Using these variable (n = 6), random forest classifier was able to discriminate between the healthy maize and early stage of PLS with and overall accuracy of 88% and kappa value of 0.75. This study demonstrates the potential of hyperspectral data in detecting the early stage of PLS in tropical maize. The study offers insight to the potential of large-scale mapping and monitoring of the
Optimal groundwater extraction for irrigated agriculture in the littoral North of Senegal under climate uncertainty, implications on irrigation water availability

A. Faye (1) ; M. Siwa (2)

(1) Senegalese Institute of Agricultural Research (ISRA), Bureau d'analyses macro-économiques, Dakar, Senegal; (2) International Food Policy Research Institute (IFPRI), Environment and production technology division, Washington, DC, United States of America

Recent studies on climate change in West Africa showed climate vulnerability of the agricultural sector in Senegal with future increase of temperatures and variable rainfall patterns (McSweeney et al., 2010; Jalloh et al., 2013). Climate perturbations will probably have an impact on Senegalese agricultural production and farmers’ livelihood.

To date, climate related research has mostly focused on rainfall crops specifically cereals and legumes in Senegal (Jalloh et al., 2013; Sène et al., 2006). Irrigated agriculture particularly horticultural crops mostly grown in the littoral north called Niayes, where at least 40% of Senegalese horticultural products are produced, have attracted less attention in terms of climate change or variable studies. In the Niayes, research have been focusing on how climate affects the aquifer recharge and they generally point out the negative ways of climate on aquifer recharge and depth (Auquair, 2010; DaSilva, 2005, 2009; etc.). Farmers grow irrigated crops during the dry season from October to June and use exclusively groundwater resource for irrigation needs. Groundwater is also used by other actors like industries, the Senegalese water company, municipalities, and rural populations. As research has shown, climate variability combined with anthropic action may threaten water availability for irrigation and other uses.

In this paper, we evaluate the optimal patterns of groundwater extraction for irrigation under climate uncertainty, and the potential gains from improved groundwater management. We establish a baseline for economic efficiency in resource management, by solving an optimization problem which captures the social planner’s decision-making problem under uncertainty and limited foresight. We construct a stochastic dynamic programming model of resource management to maximize the sum of current benefits together with the net present value of future benefits from groundwater extraction for irrigation – which also takes into account groundwater extraction costs. The stochastic extreme climate variability could also threaten water availability for irrigation and other uses.

We use an agricultural production model that is calibrated to data from this part of Senegal, using the Positive Mathematical Programming approach of Howitt (1995), and taking into account the costs of water extraction. We use the outputs of the agricultural production model to estimate the demand for water within the agricultural sector, and characterize the climate conditions with data on precipitation from International agency for meteorologies. Last but not least, the data on hydrological aspects are drawn from the literature (Gaye, 1990; Faye, 1995; El Faid, 1999; Tine, 2004; DGPRE, 2005, 2009) and the direction of management and planning of water resources (DGPRE) of Senegal.

Our results illustrate the value of improved groundwater management in the horticultural sector of Niayes, and suggest the importance of including resource management in the plans for adaptation of agriculture to climate change for this region of Senegal.

Climate change impacts on Apple trees phenology in northeastern parts of Iran

Y. Hojjatollah (1) ; C. Ahn (2) ; S. Maryam (3)

(1) University Of Isfahan, Climatology, Isfahan,Isfahan, Islamic Republic of Iran; (2) Apec climate center, Pusan, Republic of Korea; (3) Farzanegan Amin high school, Isfahan, Islamic Republic of Iran

Apple is one of the most important agricultural products of Iran. Global warming can effects on many sectors especially agricultural products and food security. One direct consequence of warming climate is the earlier onset of Bud break and flowering stages of deciduous trees such as apple in spring and earlier ripening in the end of growing season. The main objective of the present work is to assess the climate change impacts on Apple trees phenology, especially beginning of flowering in spring and ripening time of apple in the end of growing season. These two phenological stages are very important because of the sensitivity of Apple to its environment conditions. To do this we used historical data of available meteorological stations as well as CCSM4 outputs for the daily maximum and minimum for the upcoming 3 decades (2006–2039). The phenological data was collected from the Golmakan agrometric station during 1999–2006. On the base of UTAH model and using the phenological and historic climatic data we estimated the phenological phases of apple during next 3 decades. According to the results obtained by Rcp4.5 and Rcp8.5 outputs, in both scenarios significantly earlier flowering and ripening phenophases over the study area during 2006–2039 periods are estimated.

High temperature stress on agricultural crops due to climate change

L. Kyounghmi (1) ; HS. Kang, (1) ; JY. Kim, (1) ; C. Chunho (1) ; CH. Park (1)

(1) National Institute of Meteorological Research, Jeju, Republic of Korea

Temperature variability is an important determinant of the yield of annual crops, particularly when high temperature episodes coincide with flowering. Due to climate change an increase in the frequency of such episodes is expected. Hence temperature variability could become a major yield-determining factor for some regions in the decades to come. The magnitude of the impact will depend on the level of heat stress tolerance in the genotypes grown.

Mean temperature affects yield by determining the duration of developmental stages. The impact of high temperatures, particularly near flowering, is primarily on the setting of fruit or grain. Most crops are currently grown in regions where current temperatures are already close to optimum for crop production. Any further increases in mean temperatures or of short episodes of high temperatures during sensitive stages, may be supra-optimal and reduce grain yield.

In this study, we performed a spatially explicit assessment of heat stress at the global scale, considering these environmental and management aspects, to identify hot-spots of risk for four important food crops (wheat, rice, maize and soybean). We used the Global Agro-Ecological Zones Model (GAEZ v3.0) to simulate the risk of heat stress for these four crops for a 30-year baseline historical climate (1961–1990) and an alternative future climate scenario (2071–2090) considering climate change.

There was a consistent increase in the intensity of heat stress from the baseline climate to the future climate change scenario for all crops. Rice showed high heat stress intensity already for the base climate, particularly in South Asia. The main hot-spots of heat stress occurred in the continental parts of Central Asia, East Asia, South Asia and North America. In contrast, only little heat stress was predicted for maize under the base climate. However, the intensity increased highly under RCP8.5. Northern India, the Sahel region, Central South America and Eastern North America were hot spots of heat stress for maize.

A moderate heat stress intensity was predicted for soybean for the base climate with a considerable increase in intensity and extension for RCP8.5. Compared to other crops, there was less change in spatial pattern and intensity of heat stress for wheat from the Base to the RCP8.5.
The percentage of days with heat stress events increased from the base to the RCP8.5 climate scenario. This increase was most evident for rice in suitable areas of Central Asia, South Asia and Central North America where a high prevalence was predicted. On the other hand, wheat had a less pronounced change in the frequency of stress in RCP8.5.

Mainly tropical agriculture will suffer from climate change. Our results indicate that global food supply may also be affected by heat stress in temperate and subtropical regions. Without mitigation measures to combat climate change or the implementation of local adaptive technologies, countries with extensive agricultural lands in continental regions at high latitudes may experience significant crop losses.

* This work was supported by the 2015 R&D Project of the Korea Meteorological Administration "Development and application of technology for weather forecast".

**P-2223-13**

The impact of high temperature on land values in Europe

E. Massetti (1); P.S. Van (2); R. Mendelsohn, (3)

(1) Georgia Institute of Technology, School of Public Policy, Atlanta, GA, United States of America; (2) Hasselt University, Diepenbeek, Belgium; (3) Yale University, School of forestry and environmental studies, New Haven, United States of America

In Ricardian studies the relationship between climate and land values is conventionally assumed to be nonlinear. This means that an increase in temperature may be captured using a quadratic model of temperature and precipitation (Mendelsohn, Nordhaus, and Shaw 1994; Schlenker, Hanemann, and Fisher 2005; Massetti and Mendelsohn 2011; Massetti and Mendelsohn 2012). This assumption has been supported by the data as the squared terms on climate have generally been statistically significant. Schlenker and Roberts (2009) have suggested that the effect of temperature on agricultural productivity may not be captured using a quadratic functional form because it is highly non-linear at the high temperatures.

Schlenker and Roberts found a temperature threshold at about 30°C. Beyond this threshold agricultural productivity plummets.

Schlenker and Roberts (2009) limit their analysis to crop yields and use yearly data. Thus, they focus on short-term weather fluctuations and they neglect the possibility that farmers switch crops to avoid the harmful thresholds. Massetti and Mendelsohn (2014) is the first study that uses flexible functional forms to estimate the effect of growing season temperature on American farmland values and crop yields. The paper finds evidence of the hill-shaped response function for both farmland value and crop yields. But there is no evidence of temperature thresholds whether temperature is measured at 3 hour intervals, daily, or for multiple days.

With this paper we test if the relationship between temperature and land values in Europe is characterized by temperature thresholds. This is a relevant research question because if thresholds exist the increase in mean temperature will cause sizeable damages to the European agriculture. Thus, our study has direct policy implications for both mitigation and adaptation policy.

We use a flexible specifications for temperature in a Ricardian setup replicating the method of Massetti and Mendelsohn (2014) and following in spirit the method developed by Schlenker and Roberts (2009). With our method we are able to detect if farmland that is more frequently exposed to the right tail of the temperature distribution is also consistently traded at lower value than other farmland. If the Ricardian relationship is characterized by temperature thresholds we expect to find that the effect of additional warming at the highest temperature is significantly negative and much larger than at lower temperature levels.

This paper uses a unique dataset obtained by merging farm–level data for more than 37,000 farms derived by van Passel, Massetti, and Mendelsohn (2014) from the Farm Accountancy Data Network (FADN) with daily temperature data from the ERA-INTERIM dataset over 1981–2010. The rest of the paper is structured as follows. Section 2 illustrates the method used for the analysis. Section 3 describes the dataset used. Section 4 illustrates results and presents robustness tests. Conclusions follow.

**P-2223-14**

Building a statistical emulator for prediction of crop yield response to climate change: A global gridded data set approach

M. Mistry (1); E. De Cian (2); I. Wing (3)

(1) Ca’ Foscari University and FEEM, Department of economics, Venice, Italy; (2) FEEM, Venice, Italy; (3) Boston University, Dept. of earth & environment, Boston, United States of America

There is widespread concern that trends and variability in weather induced by climate change will detrimentally affect global agricultural productivity and food supplies. Reliable quantification of the risks of negative impacts at regional and global scales is a critical research need, which has so far been met by forcing state-of-the-art global gridded crop models with outputs of global climate model (GCM) simulations in exercises such as the Inter–Sectoral Impact Model Intercomparison Project (ISIMIP)—Fastrack.

Notwithstanding such progress, it remains challenging to use these simulation–based projections to assess agricultural risk because their gridded fields of crop yields are fundamentally disconnected from the continuous distributions of warming scenarios. GCMs and crop models, and not as model–specific or model–averaged yield response functions of meteorological shifts, which may have their own independent probability of occurrence. By contrast, the empirical climate economics literature has adeptly represented agricultural responses to meteorological variables as reduced–form statistical response surfaces which identify the crop productivity impacts of additional exposure to different intervals of temperature and precipitation [cf Schlenker and Roberts, 2009]. This raises several important questions: (1) what do the equivalent reduced–form statistical response surfaces look like for crop model outputs, (2) do they exhibit systematic variation over space (e.g., crop suitability zones) or across crop models with different characteristics, (3) how do they compare to estimates based on historical observations, and (4) what are the implications for the characterization of climate risks?

We address these questions by estimating statistical yield response functions for four major crops (maize, rice, wheat and soybeans) over the historical period (1971–2004) as well as future climate change scenarios (2005–2099) using ISIMIP–Fastrack data for five GCMs and seven crop models under rain–fed and irrigated management regimes. Our approach, which is patterned after Lobell and Burke [2010], is a novel application of cross–section/time–series statistical techniques from the climate economics literature to analyzing high–dimensional multi–model climate model outputs as a diagnostic methodology to elucidate uncertainties in the processes simulated by crop models, and to support the development of climate impact intercomparison exercises.

**P-2223-15**

Climate Sensitivity of Rice Yields: An Agro Climatic Zone Analysis in Andhra Pradesh, India

SR. Padakandla (1)

(1) Centre for Economic and Social Studies, Division for Sustainable Development Studies, Hyderabad, India

Observational data confirm that there have been significant regional variations in climate change patterns across India. This paper examines the effect of rainfall and temperature on rice yields of different climatic zones in Andhra Pradesh using district level panel data from 1981–2010. Analysis of data shows that the degree of impact of climate on yield of rice is varied across different climatic zones. Climatic zones which have traditionally higher temperature and less rainfall are more susceptible to variations in climate. Similarly impact of irrigation is more significant in traditionally drier zones than others.

**P-2223-16**

Widespread vulnerability of current crop production to climate change demonstrated using a data-driven approach
The projected increase in global population suggests that, among a range of measures, an increase in food production will likely be necessary to achieve food security. A great deal of effort has been focused on the so-called "yield gap", the difference between actual and potential yields. The closing of this yield gap would bring about massive increases in production. Intensification activities, such as greater irrigation utilisation and better farming practices can bring the actual yield closer to the potential yield, although such actions may not be practically everywhere. Extreme climate change, such as drought, could change this picture; crops are sensitive to their growing environment, and it is therefore inevitable that climate change will impact upon potential crop yields, changing the target for yields instead of leaving it constant. Noting and meaning that significant intensification may be required just to hold actual yields constant. Global crop models give some insight into such changes, but huge uncertainties in their processes and parameterisations make even the direction of future change uncertain. We demonstrate a complementary data-driven approach, based on observations of current potential yield and climate analogues, to assess the vulnerability of the major cereals, wheat, maize and rice, to climate change. We find that huge swathes of current cropland show strong reductions in their potential yields of major cereal crops by the mid 21st century, and, conversely, a large increase in the areas to produce these crops, wheat, maize, and rice, to climate change. We find that the largest changes are in tropical and arid areas, and out of the current high-productivity areas like the North American corn-belt. Conversely, we also find large areas where potential yields increase substantially under climate change. These areas are most prominent in the northern temperate zone, and include areas not currently under cropland. Our approach is independent of the crop modelling methodologies previously used for future yield projections, however we find our results to be consistent with several independent process-based global crop models, providing an important additional constraint on projections of future yield under climate change. Adaptation measures based on intensification of yields must consider the change in productive potential due to climate change.

Biophysical modeling of climate change impacts on crop yields in Europe by 2030-2050 and socio-economic implications

F. Ramos (1) ; M. Blanco (2) ; B. Van Doornslaer (3) ; D. Fumagalli (1) ; A. Ceglar (1) ; F. Dentener (1) ; L. Stanca (2) (1) European Commission, Joint Research Center, Institute for Environment and Sustainability, Ispra, Italy; (2) Technical University of Madrid, Madrid, Spain; (3) European Commission, Joint Research Center, Institute for prospective technological studies, Sevilla, Spain

An impact assessment of climate change scenarios on agriculture was run covering the EU-28 region and focusing on 2030 and 2050 time horizons. To assess the impact of model uncertainties, three model realizations of the Intergovernmental Panel on Climate Change (IPCC) climate scenarios were used as the input of the analysis, based on the Representative Concentration Pathway (RCP) 8.5 from the runs of global circulation models (GCM) HADGEM2-ES, IPSL-CM5A-LR and MIROC-ESM-CHEM, all bias-corrected at 0.5°x0.5° resolution. The WOFOST (World Food Studies) model has been used within the BioMA (Biophysical Model Application) platform to simulate the impacts of climate change on crop yields in all field conditions. The crop simulations were performed at 25x25 km resolution using the soil and crop parametrization of the MARS Crop Yield Forecasting System (MCYFS) that provides the European Commission operational estimation of potential crop yields in Europe. The crops covered by this study were wheat, maize, barley, rye, rice, field beans, rapeseed, sunflower, sugar beet and potato. For each of these ten crops, simulations were performed under water limited (rainfed) and potential (fully irrigated) conditions. Uncertainties are associated with the effect of CO2 on plant growth which were assessed by simulations considering or not the CO2 fertilization effect. The simulated yields were aggregated at regional, national and EU28 levels, using regional statistics on crop areas.

The crop growth simulations show in most of the cases a stagnation or a moderate increase in the potential yields of most of the crops with the notable exception of maize, sunflower and at a lesser extent potato. Under water limited conditions the picture is slightly different with more pronounced negative effects for maize and sunflower. The greatest decreases in the water limited yields occur with HADGEM2-ES GCM that simulates a drier future climate than the other two GCMs. The effects on yields, estimated by a weighted average of potential and water limited yields using data on European irrigation shares (EUROSTAT), show an overall moderate increase for the three climate scenarios, but the difference between the impacts of climate change scenarios on agricultural production and prices. The future quantitative societal developments were introduced in the model by means of an intermediate Shared Socioeconomic Pathway (SSP2).

The results suggest that agriculture markets projections to 2030 are sensitive to changes in crop productivity and, therefore, to the uncertainties linked to climate change. They show as well that market forces can reverse the effects of climate induced yield changes with a decrease (increase) in production when yields increase (decrease). The price changes will induce adjustments both on the intensity of production and on crop areas. A sectoral analysis indicates that the regional variability in prices and areas is greater for oilseeds than for cereals. Overall the modelling exercise demonstrates that a decrease of the EU agricultural income for all the scenarios with the CO2 fertilization effect simulated and a moderate increase when the CO2 fertilization effect is ignored. The limitations of these conclusions will be explored.

Interactions of Mean Climate Change and Climate Variability on Food Security Extremes

A. Ruane (1) ; S. Mcdermid, (2) ; C. Rosenzweig (3) (1) NASA Goddard Institute for Space Studies, Climate Impacts Group, New York, NY, United States of America; (2) New York University, New York, NY, United States of America; (3) NASA Goddard Institute for Space Studies, New York City, United States of America

The Coordinated Climate-Crop Modeling Project (C3MP) has conducted a common set of sensitivity tests on more than 1100 simulation sets representing different farm systems in more than 50 countries, with carbon dioxide, temperature, and precipitation change sensitivities gauged for ~20 crop species and ~20 crop models. Here we present an analysis of C3MP results indicating how mean climate changes are likely to affect variability and extreme events within future time periods.

Recognizing that climate change will affect agricultural systems both through mean changes and through shifts in extreme variability and climate extremes, this paper examines how changes in yield will be impacted by changes in rainfall and temperature variability. The model simulations that are presented in this paper elucidate several aspects of these changes. First, mean climate changes can affect yields across an entire time period. Second, extreme events (when they do occur) may be more sensitive than the year-to-year changes, with for instance an overall increase in winter wheat yields for most of the EU 28 regions and an overall decrease of maize (summer crop) yields, with in both cases a reversed result for northern Europe.

Focusing on the year 2030, a bio-economic approach was provided to jointly assess biophysical and socio-economic effects of climate change on agriculture, providing both global level analysis as well as regionalised for the EU. The global agro-economic model CAPRI (Common Agricultural Policy Regionalised in spatiotemporal perspective) has been used to simulate the effects of climate induced yield changes on agricultural production and prices. The future quantitative societal developments were introduced in the model by means of an intermediate Shared Socioeconomic Pathway (SSP2).

The results suggest that agriculture markets projections to 2030 are sensitive to changes in crop productivity and, therefore, to the uncertainties linked to climate change. They show as well that market forces can reverse the effects of climate induced yield changes with a decrease (increase) in production when yields increase (decrease). The price changes will induce adjustments both on the intensity of production and on crop areas. A sectoral analysis indicates that the regional variability in prices and areas is greater for oilseeds than for cereals. Overall the modelling exercise demonstrates that a decrease of the EU agricultural income for all the scenarios with the CO2 fertilization effect simulated and a moderate increase when the CO2 fertilization effect is ignored. The limitations of these conclusions will be explored.
past and future changes in climate of rice-wheat cropping zone in Punjab, Pakistan

B. Syed Ahsan Ali (1) ; G. Rasul (1) ; A. Ruane (2) ; G. Hoogenboom (3)
(1) Pakistan Meteorological Department, Research and Development Division, Islamabad, Pakistan; (2) NASA Goddard Institute for Space Studies, Climate Impacts Group, New York, NY, United States of America; (3) Washington State University, Washington, United States of America

Agriculture is ranked Pakistan’s top among economic sectors vulnerable to the potential impacts of climate change. The agricultural production system is directly affected by weather inputs (temperature, solar radiation, and rainfall) that are projectd to change in the future (following increases in carbon dioxide and other greenhouse gases). Climatic extremes such as drought, floods and heat waves, are expected to increase with detrimental consequences for agriculture and livestock production, but changes in mean climates also pose challenges to sustainable development. This study presents climate change results for five districts within the major rice–wheat productivity zone of Punjab province in Pakistan. The results are focused on RCP 8.5 mid-century (2040–2069) scenarios derived from five global climate models (GCMs) output and the Kharif (June–October) and Rabi (November–April) seasons. Analysis of recent historical weather data of Sialkot and Sheikhupura districts shows an increase in minimum temperatures and maximum temperatures and a large variation in rainfall. This temperature change and variability in rainfall is expected to enhance further as we approach the 2050s. Mean maximum temperature is projected to increase by 2–2.5°C during rice growing (Kharif) season and 2.4–2.7°C during the wheat growing (Rabi) season. Rainfall during rice growing season is expected to decline, with the greatest impact indicating an increase of 25%-35 % in the study region, while a minimal change is expected during the Rabi season. The projectd increase in monsoon intensity corresponding with the projected increase in rainfall is uncertain without doubt about the crop water demand satisfaction. However, simultaneous increase in day and night temperature may affect the growth and development at some critical phenological stages.

Economic impact of climate change and benefits of adaptation in maize production in Southern Africa: Case study from South Africa, Namibia and Botswana

M. Teweldemedhin (1)
(1) Polytechnic of Namibia, Agriculture, Windhoek, Namibia

The paper applied the Trade-Off Analysis-Multi-Dimensional (TOA–MD) model to evaluate the economic impacts of climate change and benefits of adaptation strategies for maize–based agricultural production systems in Southern Africa. The analysis was based on data collected from three countries, South Africa, Namibia and Botswana. The empirical analyses combined simulated baseline and future simulated yield from the Decision Support Systems for Agrotechnology Transfer (DSSAT) model, under five different climate scenarios selected from 20 Global Circulation Models (GCMs). The paper focused on analysing three main objectives: (a) the sensitivity of current crop production systems to future climate change, (b) the sensitivity of future crop production systems to future climate change and (c) the benefits of adaptation in the future. The empirical results show that current and future crop production systems in the three study countries are sensitive to future climate change and yields would decline if no adaptation strategies are implemented. The results with the adaptation package show positive gains in yields, farm net income and nutritional outcomes. In addition, the percentage of vulnerable farmers decrease for the scenario with adaptation compared to the other two scenarios without adaptation. Since various assumptions and uncertainties are associated with using the proposed approach, the results should be interpreted with caution.

Despite these limitations, the methodology presented in this study shows that the way that realistic adaptation strategies could improve the livelihoods of smallholder farmers.

Modelling of Climate Change Impact on Maize Yields in Croatia

V. Vucetic (1)
(1) METEOROLOGICAL AND HYDROLOGICAL SERVICE, AGROMETEOROLOGICAL DEPARTMENT, ZAGREB, CROATIA

Analyzing agricultural systems and modelling the potential impact of crop production is a very important topic, particularly nowadays as food supplies are becoming scarcer in many parts of the world and the need for all people to have sufficient food. As climate change has become an issue of increasing concern, the need to predict the way that realistic adaptation strategies could improve the livelihoods of smallholder farmers.

P-2223-19

P-2223-20

P-2223-21

P-2223-22
ABSTRACT BOOK

P-2223-22

Two possible future climate scenarios for AgMIP-GGCMI – Sulfate Injection Climate Intervention and Regional Nuclear War

L. Xia (1); A. Robock (2); J. Elliott (3)
(1) Rutgers University, Department of environmental sciences, New Brunswick NJ, United States of America; (2) Rutgers University, Department of Environmental Sciences, New Brunswick, NJ, United States of America; (3) University of Chicago, Chicago, United States of America

Climate is one of the most important factors determining crop yields and world food supplies. To be well prepared for possible futures, it is necessary to study yield changes of major crops under different climate scenarios. Here we propose two possible future climate scenarios for the global crop modelling community: stratospheric sulfate climate intervention and regional nuclear war. Although we certainly do not advocate either scenario, we cannot exclude the possibilities: if global warming is getting worse, society might consider deliberately manipulating global temperature; if nuclear weapons still exist, we might face a nuclear war catastrophe. Since in both scenarios there would be reductions of temperature, precipitation, and insolation, which are three controlling factors on crop growth, it is important to study food supply changes under the two cases. There have been 12 general circulation modelling groups participating in the Geoengineering Model Intercomparison Project (GeoMIP) and three modeling groups have conducted the same regional nuclear war simulations, with fires from targets injecting 5 Tg soot into the upper troposphere. We are approaching a robust understanding of climate changes under the two scenarios. We have conducted simulations for China, because of its high population and crop production in the world and we have been working on global agriculture impact under those two scenarios using the crop model in the Community Land Model (CLM-crop). Also, we are preparing protocols and datasets for the Gridded Crop Modeling Initiative (GGCMI), which will conduct a multi-crop multi-model assessment of crop yields under the above two simulated climate scenarios. Preliminary results indicate significant changes in patterns of global food production, with substantial losses in major bread baskets around the world under the simulated regional nuclear war scenarios. Here, we would like to invite more global crop modelling groups to be involved in this project, and hence to gain a better understanding of global agriculture responses under the two possible but unpleasant future climate scenarios.

2224 - Agrarian and pastoral societies: adaptive strategies and innovations

ORAL PRESENTATIONS

K-2224-01

Climate Compatible Development in Mongolia: analysis of vulnerability and adaptation response to global changes

D. Ojima (1); C. Togtokh (2); K. Galvin (3)
(1) Colorado State University and Future Earth US Hub, Natural Resource Ecology Laboratory, Fort Collins, United States of America; (2) Institute for Sustainable Development, National University of Mongolia, Ulaanbaatar, Mongolia; (3) Colorado State University, School of global environmental sustainability, Colorado, United States of America

INTRODUCTION: Climate change and variability, market and policy changes are shaping pastoral communities' decisions on what pathways their future livelihoods will take and how the steppe landscapes and river basins, are managed. Recent droughts and damaging winter storms (zuds) of the past two decades have exacerbated the situation and undermined the natural capital on which the pastoral livelihoods depend. River basins are critical natural resources for well-being of the social and ecological systems in Mongolia. River basins provide the ecosystem services which support pastoral communities, and industrial and urban development. Green development strategies are strongly dependent on water resources.

For this study our team worked in nine <sums> (i.e., county level administrative areas) in three river basins in two provinces (aimags) to collect household data from 144 households. We selected three <sums> in each river basin, representing forest steppe, steppe and desert steppe regions for comparison across river basins and ecozonal zones. We also collected census data from the <aimags> and national level to understand trends at the level of regions and river basins.

FINDINGS: Drought management. Unlike for <zud>, people report very few opportunities of help with drought beyond their household and kin relations. By far the most frequently cited strategy for coping with drought is to do <otor> – long distance movements with livestock.

Cooperation. The most frequently listed “best coping strategy” across all ecosystem types was for herders to have better cooperation, both among themselves and with administrators. They frequently expressed the idea that people working alone cannot accomplish much compared to when they work together. Furthermore, one herder said that in the past, “we deeply understood that the most important thing is cooperation during natural disasters. Herders also want information, training and to cope with climate and market changes.

Protection and management of pastures, and support to do <otor> were next set of important strategies after cooperation. Protection of otor pastures by local governments is an important strategy for protection from mining expansion in addition to improved management of seasonal pastures.

ADAPTATION ACTIONS: Integrated river basin management plans. Develop cross ministry and cross-sectoral working groups to develop and implement plans and actions which cut across land, water, livelihood resource needs. Incorporate assessment and monitoring of natural resources under two scenarios. Conduct change impact analysis, especially droughts on natural capital, ecosystem services, and livelihood needs. Create governance structures which incorporate both technical and stakeholder perspectives.

Monitoring and Assessment. Establish indicator metrics for multiple water, land and livelihood resources and outcomes. Evaluate vulnerability and adaptive capacity taking into account natural capital, ecosystem services, and livelihoods. Provide early warning for zud, based on summer drought and grazing conditions, and also zud forecasting.

Training and capacity building. Provide training for integrated management which provides tools and skills for assessing and monitoring natural capital, ecosystem services and socio-economic conditions across the river basins. The training tools would include geospatial data gathering on climate, natural resource distribution and usage, land use patterns, community-based planning and management practices, sum, bag and other informal boundaries. Provide adaptation and green development courses for local communities and school systems. Also provide training to research on climate change and communicate information on climate change, natural resource management, adaptation and green development opportunities. For example, develop a webinar program to learn and disseminate skills.
Innovative adaptation of pastoral systems to climate change: Case study in Mongolia

C. Togtokh (1); M. Watanabe (2); S. Watanabe (2)
(1) Institute for Sustainable Development, National University of Mongolia, Ulaanbaatar, Mongolia; (2) Chuo University, Research and development initiative, Tokyo, Japan

Synergy of scientific, technological, governance and financial dimensions is required for adaptation of pastoral social–ecological systems to climate and global changes.

- Scientific understanding of vulnerability and adaptive capacity of local and regional social–ecological systems is the basis for success of response actions.
- Application of advanced technologies with co-benefits for mitigation and adaptation is one key for responding to climate change.
- Without financial mechanisms, which enables application of innovative technology, there will be no technological advancement with improved adaptation and mitigation.
- Governance for sustainable development, integrating environmental, social and economic dimensions, is another key for adaptation towards sustainability.

We will demonstrate a case study in Mongolia, integrating all four dimensions.

Permafrost melting due to global warming is likely to be critical in variable leading towards desertification of rangelands in Mongolia, reducing water availability for plant growth in the spring - critical season for pastoral systems. Pastoral systems are becoming vulnerable because of interacting dynamic factors such as drought, overgrazing and “zud” (severe winter condition for livestock).

Improved early warning systems with ICT technology based on drought/grazing impacts and winter forecasting are critical for early harvesting of livestock and preventing of livestock loss during “zud”. Innovative meat storage systems with application of renewable energy-based freezing system is going to be demonstrated in Mongolia which will be co-benefiting mitigation and adaptation.

The Government of Japan and the Government of Mongolia signed the agreement on Low Carbon Development Partnership, using the Joint Credit Mechanism (JCM). The Parliament of Mongolia passed Green Development Bill in 2013, which serves as a bases for governance towards sustainability. Climate compatible development, integrating adaptation, mitigation and sustainable development, was a core of the policy document.

It is a challenge to demonstrate and observe how technological, governance, financial and scientific factors will impact at local community level. Management of innovative technology as new commons by local pastoral community is critical for strengthening the traditional adaptive capacity and resilience of pastoral systems in Mongolia.

Climate variability as experienced by farmers

C. Leclerc (1); C. Mwongera, (2); V. Moron (3)
(1) CIRAD – UMR AGAP, Crop Diversity Dynamics, Societies and Environments, Montpellier, France; (2) International Center for Tropical Agriculture (CIAT), Nairobi, Kenya; (3) Aix Marseille Université, and CEREGE, Aix en Provence, France

The typical approach of estimating crop response to future climate scenarios may be inappropriate in the case of smallholder multi cropping rain-fed agriculture. Indeed, a crop–by–crop simulation, based on current varieties, cannot take into account the dynamics among crops as well as within crops i.e. among varieties, in time and space. We implemented a data driven model, involving interactions between cropping system dynamics and past climate variations, taking into account the diversity of farmers’ experiences and socio–cultural organization.

In Kenya, farmers who adopted maize a few years ago are still cultivating traditional sorghum and pearl millet varieties, while others abandoned them earlier in favour of maize. Farming systems were thus dynamic, with different crop assemblages over time. Thus, retrospectively, farmers’ capacity to mitigate crop failure risk due to extreme rainfall events has never been constant. Has the farming system lost part of its capacity to cope with climate variability, as maize is known to be less resistant to drought than sorghum and pearl millet? While this is usually demonstrated using yield parameter, we used seed loss reminiscence about the period 1961–2006 and climatic records for three altitudinal levels on the eastern slope of Mount Kenya were analysed. Over the period, 328 seed loss events were reported independent by 208 farmers, for eight main crops of their rain-fed farming systems. The causes given for these losses according to farmers’ experience and knowledge were recorded yearly. We first assessed whether these causes were related to recorded rainfall values, and, second, analysed the proportion of lost seed on a yearly basis, crop by crop and across the entire Mount Kenya, taking into account the diversity of farmers’ experiences and socio–cultural organization.
We hypothesize that feedbacks between the biophysical-social system and spatial interactions must be accounted for in order to be able to study scenarios of agricultural evolution and water management policies, not only in terms of sustainability at the scale of the watershed but also in terms of spatial sustainability of both the groundwater resource and the evolution of socio-economic inequity over time. Consequently, we propose to develop a model framework that combines hydrology, agronomy and economy.

We will also insist on one of the critical challenge in implementing such integrated models, which is to develop the human component of this framework to account for farmer decision that occur at different time scales. We propose to base this module on decision rules to allow the representation of farmer adaptation to a changing environment.

K-2224-06

Adaptation of Irrigated agriculture to climate CHAnge: Retrieving relevant information for distributed modelling of impact of Climate Change of water resources

S. Muddu (1)

(1) Indian Institute of Science, Civil Engineering Department, Bangalore, India

Developing integrated assessments of the sustainability of irrigated agriculture is critical in the context of ever growing pressure on water resources. A wide variety of models have been developed for simulating future scenarios of land-use change, climate change or ex-ante evaluation of management policies. Such models usually fail to account for feedbacks of shrinking water resources on farmer strategies, and tend to neglect the biophysical and socio-economic interactions spatially and temporally within the watershed.

In this talk, we will present innovative approaches that are conceived and tested within the Indo-French CEFIPRA project “AICHA” (Adaptation of Irrigated agriculture to climate CHAnge, 2013–2016) based on a watershed in South India where a long term environmental observatory has been setup.

One of the critical challenge is to implement the integrated agro-hydrological model in a distributed way over the whole watershed. We propose to use methods based on remote-sensing to collect data on land use and soil properties.

One of the challenges of using such models for scenario testing in a distributed way is the need for accurate knowledge, for example for soil and crop parameters (Lauwery and Guerif, 2005) which are scarcely available for tropical conditions. As an example of the development of innovative methodologies fostered by the project, we present a method to retrieve soil parameters using remote sensing and crop model inversion (Sreelash et al., 2012; 2013).

Further, another challenge is for developing future projections of water balance components based on such an integrated agro-hydrological model would be the choice of the climate model forecasts to drive the model. This is commonly achieved by driving the agro-hydrological model with the bias-corrected precipitation data from the GCMs. The approaches that are being used for disaggregate and bias-correct the precipitation from the GCMs of CMIP3 will be presented.

P-2224-01

Strategies of farmers to rainfall variations in the municipality of Zè in Benin

VN. Adjahossou (1); SB. Adjahossou (2); FE. Dovonou (3); DF. Adjahossou (4)

(1) Université d’Abomey–Calavi, Géodétrie, Cotonou, Benin; (2) Université d’Abomey–Calavi, Génie de l’environnement, Cotonou, Benin; (3) Université d’Abomey–Calavi, Faculté des sciences et techniques, Calavi, Benin; (4) Université des sciences et techniques de Porto Novo, Benin.

In the studied watershed, spatial heterogeneity in groundwater gradients has resulted from intensive groundwater pumping in the valley that started in the early 1990s. The decline in groundwater level provoked the disconnection between the groundwater and the river bed, and the main permanent rivers turned into ephemeral small streams. Wells are being recently drilled in the upland areas and groundwater irrigation is increasing. Our analysis suggests that these contrasted evolutions are closely linked to the spatial distribution of soil types and groundwater availability, besides access to market and knowledge.

In this talk, we will present innovative approaches that are conceived and tested within the Indo-French CEFIPRA project “AICHA” (Adaptation of Irrigated agriculture to climate CHAnge, 2013–2016) based on an agricultural watershed in South India where a long term environmental observatory has been setup.

One of the critical challenge is to implement the integrated agro-hydrological model in a distributed way over the whole watershed. We propose to use methods based on remote-sensing to collect data on land use and soil properties.

One of the challenges of using such models for scenario testing in a distributed way is the need for accurate knowledge, for example for soil and crop parameters (Lauwery and Guerif, 2005) which are scarcely available for tropical conditions. As an example of the development of innovative methodologies fostered by the project, we present a method to retrieve soil parameters using remote sensing and crop model inversion (Sreelash et al., 2012; 2013).

Further, another challenge is for developing future projections of water balance components based on such an integrated agro-hydrological model would be the choice of the climate model forecasts to drive the model. This is commonly achieved by driving the agro-hydrological model with the bias-corrected precipitation data from the GCMs. The approaches that are being used for disaggregate and bias-correct the precipitation from the GCMs of CMIP3 will be presented.
d’Abomey–Calavi, Faculté des sciences agronomiques, Cotonou, Benin

Current climate change in several parts of the world are real obstacles to the development of agricultural activities. This change is characterized by irregularity and bad distribution of rainfall along the year. Sometimes rainfall occurs in abundance during a short period when crops don’t need a lot of water. These difficulties are greater for farmers in its is as those in South–Benin. Agriculture is practicing for the most part, highly dependent on rainfall agriculture.

Documentary research, observation and investigation in a real area have permitted to collect the necessary data during this research. The surveys were conducted with 202 farmers living and operating in the Municipality of Zè. The area of study is located in Atlantic department. It is situated between 6° 32 and 6° 87 N latitude and between 2° 13 and 2° 26 E longitude. It covers an area of 653 km². Zè is the largest municipality in the department represents 19.88% of the territory.

The climate is sub–equatorial and is characterized by rainfall amounts higher or lower, a relatively small annual thermal amplitude (less than 5°C) and the succession of four distinct seasons: a long rainy season from mid–March to mid–July, a short dry season from mid–July to August; a small rainy season from September to November and a long dry season from December to mid–March. The frequencies of rainfall and water levels are experiencing more and more disturbances in recent years. This drought system is not dense. Only the northern part of the municipality is watered by the tributaries of the river Oueme mainly Sô river.

It appears from the use of the data collected that people (more than 84% rural) of the Zè municipality develop strategies to cope with climate change. In general, the agricultural calendar is modified to comply with new rainfall rates.

The combination of cultures and multiple or replanting seedlings are practiced in place to reduce the impact of drought variations on Agriculture in Zè. Changing the cropping calendar

Crop calendar takes account of the seasonal precipitation. Land preparation takes place in the late dry seasons. From the first rains, the farmers start planting. To the rainy season, sowing takes place from mid–March to mid–April and early rainy season, from mid–August to mid–September for maize. Currently, with late rains, sowing takes place later. Generally, farmers expect three to four rains before planting when they consider soil humidity is sufficient to favor seed germination and seedling emergence. But some farmers take the risk of planting after heavy rain and other precipitation when not following the operation, they resume planting.

In localities of great pineapple production like municipality of Zè young farmers interested in increasingly the operation, they resume planting.

The combination of cultures is to produce two or more crops simultaneously in the same field (Steiner, 1985). It contributes to reduce natural risks that could affect crop yields including breaks rain. Trenbath, (1993) showed that the species that grow in monoculture are less attacked by pests that in mono culture and improves productivity per unit area (Adjahossou, 2005 and Adjahossou, 2012). According to some farmers, the association of cultures would better conserve soil and humidity. This could be explained by the limitation of evapotranspiration due to the microclimate created by the coexistence of two or more cultures. In the study area, commonly associated crops are maize–cassava, maize–cowpea and corn–pineapple.

It should be noted that these strategies have many limitations and need to be improved significantly.
in the past climate, present and future, with combination of emission scenarios, climate models and downscaling methods to achieve a spatial resolution consistent with the decisions of farmers and foresters to adapt production and the corresponding economic sectors. Several crop and forestry models should also be used in order to take into account the uncertainty related to the ability of impact models to reproduce all the processes. Such a portfolio of services requires calculations in the past climate, present and future, with combination of emission scenarios, climate models and downscaling methods to achieve a spatial resolution consistent with the decisions of the farmers and foresters to adapt production and related economic sectors. Several crop and forestry models should be proposed to represent the uncertainty due to the wide range of impact models, reproducing more or less processes. Finally, multi-criteria evaluation (economic, social, biotech) adaptation options will be made possible.

This project is developed by Inra and partners (Irstea, BRGM, CEA, CNRS, Universities, Météo France, ...), under the umbrella of Allenvi, the National Research Network for the Environment.

P-2224-04

The INRA metaprogramme on Adaptation of Agriculture and Forests to Climate Change (AAFCC)

T. Caquet (1); N. Breda (2); J.P. Amigues (3); C. Gascuel-Odoux (4); K. Chalvet-Monfray (5); P. Debaeke (6); J.M. Touzard (7); J.F. Soussana (8)

(1) INRA, Uar 1275 ecology of forests, grasslands and freshwater systems division, Champenoux, France; (2) INRA, UMR 1137 INRA UL Forest Ecology and Ecophysiology, Champenoux, France; (3) INRA, SAEZ, Toulouse, France; (4) INRA, UMR 1063 agroecologies innovations for the 21st century “soil, water and hydroxysystem-sas”, Rennes, France; (5) INRA, UFP 346 animal epidemiology-epi-a, Saint Genès Champagnolle, France; (6) INRA, UMR 1248 inra-inpt agroecologies innovations ruralities landscapes of the 21st century, (7) INRA, Montpellier, France; (8) INRA, Paris, France.

The metaprogramme on Adaptation of Agriculture and Forests to Climate Change (AAFCC) has been launched by the French Institute for Agricultural Research in 2011. It aims at coordinating, promoting and integrating the research activities to overcome the scientific and societal barriers that could restrict adaptation. This proactive and pluridisciplinary strategy involves cooperation with French and foreign academic and socioprofessional actors. It should ensure rapid results and progress, for example in multi-criteria evaluation of adaptation options. Favouring the dialogue between disciplines, AAFCC provides a framework for the various research projects on adaptation of agriculture and forests to climate change. Discipline-related sciences, human sciences, and environmental sciences, ecology, genetics, agroecology and hydrology are mobilised to cover the range of questions raised by adaptation to climate change. The choice of an interdisciplinary approach at the sector or territorial level. The issues and general objectives of the programme can globally be ordered according to the increasing response times of the systems, from short- to long-term, and the intensity and ‘active’ nature of the adaptation: from palliative or support actions, to technological and technical or collective organisational breakthroughs. Such breakthroughs require strong innovations and a thorough socio-economic assessment.

AAFCC is fully in line with the European Joint Programming Initiative on ‘Agriculture, food security and climate change’. It is coordinated to enhance coordination of national research programmes. Research projects address annual and perennial crops, livestock, forests, biodiversity or water and soil resources. AAFCC has also promoted training of young scientists through PhD grants and postdoctoral fellowships. Since 2011, AAFCC has supported more than 25 national research projects and international actions and supported various European initiatives through funding of some ERA-NETS. It also supports international (for example cooperative projects with India or South Mediterranean countries) or global (for example cooperative projects with India or South Mediterranean countries) or global (for example cooperative projects with India or South Mediterranean countries) projects in addition to national projects. The general objectives of AAFCC and its main achievements are presented and discussed.

P-2224-05

Adaptation of smallholder farmers to climate change in the tropical Andes

O. Dangles (1); C. Carpio (2)

(1) IRD, Quito, Ecuador; (2) ESPOCH, Cedeterra, RIOBAMBA, Ecuador.

In recent years, the precarious state of food production systems has become a focus of attention of scientists, policy makers, and consumers alike. The growing number of challenges including uncertainties and risks associated with climate change, unprecedented price hikes for basic food, and agricultural intensification. In the tropical Andes, climate and habitat changes are amongst the most serious threats to sustainable development, with adverse impacts expected on the environment, human health, economic activity and food security. Over the last decade, the Andes have also experienced socio-economic and institutional changes that have increased the pressure on natural resources, weakened the internal social organization and caused cultural erosion in the Andean society, reducing the capacities of populations to overcome them.

Global climate change represents a major threat to sustainable farming in the tropical Andes. Farmers have used local ecological knowledge and intricate production systems to cope, adapt and reorganize to meet climate uncertainty and risk, which have always been a fact of life. Thus, the traditional systems are already resilient, but the predicted effects, rates and variability of climate change may push them beyond their range of adaptability.

This presentation summarizes 10 years of studies performed by our group within a transdisciplinary (from social sciences to ecological sciences to earth sciences) and multi-methodology frameworks (from landscape surveys by drones to agent based modeling to participatory research). It examines the extent of actual and potential impacts of climate variability and change on small-scale farmers and describes how climate change impacts agriculture through two main study case: 1) the consequences of deglaciation and changes in hydrology on biodiversity and land users in high altitude pastures (bofedales) of Bolivia (see www. biothaw.ird.fr) and 2) the effect of temperature variability on the control of pests and disease populations in crop landscapes of Ecuador (see www.manpest.ird.fr).

The presentation highlights some promising adaptive strategies currently in use by or possible for producers, rural communities and local institutions to mitigate climate change effects while preserving the livelihoods and environmental and social sustainability of the region. In particular, it presents how the concept of adaptive management, «a systematic process for continually improving management policies and practices by learning from the outcomes of previously employed policies and practices», may provide mechanisms to adjust to change and uncertainty related to climate change.

P-2224-06

Farm level adaptation to drought: the case of maize production in Shanxi province, China

K. De Bruin (1); S. Glomsrud (1); T. Wei (1)

(1) CICERO (Center for International Climate and Environmental Research – Oslo), Climate economics, Oslo, Norway

Changes in temperature and precipitation will impact food production across the globe. The latest IPCC AR5 WG1 assessment report states that although there is low confidence in global-scale observed trends in drought, there are regional changes, such as the weakening of the East Asian summer monsoon and the Indian summer monsoon, which has led to increasing drought in northern China. Shanxi province, located in the north of China, is one of the most vulnerable provinces to be impacted by drought, especially impacting maize production.

Within the research programme on climate change and
Chinese agriculture we assess the impacts and costs to agriculture associated with expected change in risk of extreme events on maize production in Shanxi province. We investigate how local adaptation to climate change through the implementation of adaptation options reduces the vulnerability of farmers. Uncertainty about the extent of the impact of climate change on drought risk calls for flexibility regarding the implementation of adaptation options. Where one should avoid over-investment in case damages increased less than expected while at the same time facilitating proportionate adaptation if damages become higher than expected.

The objective of the paper is to show how drought risk affects the decision to invest in adaptation options. We conduct an extended cost–benefit analysis to address adaptation challenges of farmers in Shanxi province by simulating their investment decisions on resources allocation and adaptation options under uncertain climate change impacts in order to maximize income and reduce the impact of an extreme event on crop production. The costs and benefits of three different adaptation options are considered, namely the implementation of drip irrigation, change of crop variety, and change of crop. Our case study of adaptation at the farm level in Shanxi province provides insights into the nexus between economic decision-making, climate change and adaptation in the agricultural sector.

P-2224-07
Increasing within-field diversity to foster agro-ecosystem services and cope with climate change

J. Enjalbert (1) ; X. Le Roux (2) ; V. Allard (3) ; B. Andrieu (4) ; S. Barot (5) ; J. Borg (6) ; D. Descoureaux (7) ; C. De Vallavieille-Pope (4) ; A. Gauffretaud (4) ; L. Goldringer (6) ; S. Lemaré (8) ; S. Saint-Jean (4) ; T. Wheatamix Consortium (6) ; E. Porcher (9)

(1) INRA, plant Breeding, Gif sur Yvette, France; (2) INRA, Ea, Lyon, France; (3) INRA, Bap, Clermont-Ferrand, France; (4) INRA, Gignac, France; (5) IRD, Paris, France; (6) INRA, Gif sur Yvette, France; (7) Chambre d’agriculture du Lioré-et-Cher, Blois, France; (8) INRA, Grenoble, France; (9) MNHN, Paris, France

During the 20th century, agriculture experienced major gains in productivity via homogenization and intensive use of inputs. This model is jeopardized by the awareness of rapid global change, in particular climate change, and the need for greater agricultural sustainability. Crop genetic diversity should play an essential role in this context, as it could promote various ecosystem services essential for adaptation to climate change. Increasing within field diversity through the use of cultivar mixtures is a promising solution, with successful "success stories" in the past. Despite the abundant bibliography demonstrating the interest of intra-specific crop diversity, cultivar mixtures are poorly developed worldwide. Within the WHEATAMIX project studies the interest of mixing wheat genotypes to reinforce the sustainability and resilience of agricultural production and the provision of various ecosystem services. Based on a highly multidisciplinary approach we analyze the interactions among genotypes and with the environment, to develop new methods for breeding and/or combining wheat varieties to obtain performing blends in a global context. Completeness of experimental schemes are being deployed: i) a diversity experiment (Eighty–eight wheat plots with 1, 2, 4 or 8 varieties, under low input) to quantify over several years the variety diversity effects on ecosystem services; ii) replicates of the same diversity experiment in 4 sites across France, to test the robustness of wheat diversity effects under a wide range of climate; iii) a community experiment in the Paris basin, to compare the ecological and techno–economic performance of blends with that of monocultures, using direct links with key stakeholders. The results provide a comprehensive characterization of the multiple ecosystem services provided by genetic diversity (yield stability; regulation of foliar diseases; insect pest and weeds; biological maintenance of soil fertility; biodiversity conservation), and the trade–offs and synergies that exist among ecosystem services. The result also guide the selection of variety mixtures and corresponding bundles of practices to deliver particular groups of services to tackle the climate change issue.

P-2224-08
Assessing the determinants of alternative adaptation strategies at farm level: the case of wine growers in South-East France

N. Graveline (1) ; M. Grémont (1)

(1) BRGM, Environnement, Water & Ecotechnologies, Montpellier, France

Climate change is expected to have a double effect on water resources, directly, by potentially reducing the recharge of water resources and, indirectly, through an increase of water demands and uptakes, mainly through irrigated farming. Understanding the rationale leading farmers to adapt to climate change is thus a major challenge for water management because one of the strategies to adapt to increasing crop water requirement is irrigation. This will induce new water demands, thus understanding the determinants of irrigation choice is a challenge for robust water planning both in terms of water conveyance infrastructure planning and environmental impacts on water resources. It is also a central issue for agricultural economics and policy. One of our main assumptions to this analysis is to state that climate change is just one of the multiple changes farmers are facing together with regulatory changes (right to irrigate on a regular basis since 2006), economic changes linked to the changes in consumers demand and wine market in general, and tecnological changes. Adaptation must be seen as a response to all the perceived changes and not to a particular one. Apriori, also, adaptation has always been at the core of farmer’s experience.

In order to explore these questions, we concentrate on the case of wine growers in South-East France (Languedoc-Roussillion) where the context is changing: irrigation is authorized on a regular basis since 2006 and a large water conveyance infrastructure is being constructed enabling for new water resources. We surveyed wine growers in Languedoc-Roussillon via a detailed Internet questionnaire sent to more than 3000 winegrowers to understand the determinants of agricultural practices and strategic choices (planting, structural size change, commercialization). The diffusion of the questionnaire was realized via the mail listings of professional organisms (Chambre d’agriculture, cooperatives...). We collected data on current and future practices relative to soil–plant water management, perceptions of past economic, regulatory, technical and climate changes and social and economic characteristics such as objectives that wine growers are pursuing with their activity (improving wine quality, preserving tradition, etc.). For all completed and validated survey, various variables were considered: the size of the farm is systematically associated to each farm: rain, temperature, soil water capacity, elevation.

A representative sample of 363 wine growers is used for a descriptive and econometric analysis. 30% of our sample is already irrigating vine while up to 28% is considering this decision. We consider two main types of determinants and explore their relative contribution in explaining the adoption of water management practices at farm level. Terroir-like variables and socio-economic variables, including main objectives that vine growers are pursuing with their activity are explored as determinants. The results confirmed that both terroir and socio-economic determinants play a significant role in the implementation of adaptation actions among wine growers. Apart from past changes, determinants of past changes are determinants of adaptations: for instance perceptions of regulatory changes are determinants of existing irrigation whereas perception of climate change is a determinant of having the project to irrigate in the future. This year, having that its own cellar (wine transformation), increasing its size, being part of professional networks, producing wine of good quality and developing commercial strategies are determinants of resilient farms.
Combining crop physiology, breeding, socioeconomics and modelling to the targeting of genotypes to "wheat hotspots" in Mexico

J. Hellin (1) ; G. Molero (2) ; P. Alderman (2) ; K. Sonder (1)
(1) International Maize and Wheat Improvement Center, Socio-economic program, Mexico, Mexico; (2) International Maize and Wheat Improvement Center, Global wheat program, Mexico, Mexico

Climate change is a global problem but its potential effects on crop production, as well as appropriate adaptation strategies and breeding programs, depend on the region. In Mexico, climate change is particularly vulnerable to climate change with models projecting a reduction in national productivity of at least 34%. The main cereals crops such as maize and wheat are particularly vulnerable, with climate change expected to reduce yields by 10-20%. In order to assist crop breeding programs to select and target wheat genotypes, it is important to identify current and future agro-ecological zones for wheat production in Mexico and, subsequently, appropriate wheat genotypes for these zones. Already established networks for multi-environments trial evaluations worldwide (such as the International Wheat Improvement Network (WIN)) can be used to identify with our pre-calculated adapted wheat genotypes in order to recommend which ones could have greater impact in different agro-ecological zones in Mexico. This is particularly important to rain-fed areas of Mexico where scare information on genotype performance is available. To complement this approach, detailed studies on the same genotypes evaluated for physiological traits during different years can help to determine which specific traits confer to the genotypes an advantage under given environmental conditions.

We focus on appropriate climate adaptation strategies for wheat in rain-fed areas in Mexico. We use a bio-economic modeling framework involving crop, spatial and economic variables to identify "wheat hotspots" i.e. areas in Mexico which are particularly vulnerable to increased drought and heat stress. Drawing on data from international wheat trials at 25 sites worldwide, we identify wheat lines than could be released as varieties most suited to these predicted wheat hotspots. Additionally, combinations of crop simulation models together with geographic information systems (GIS) help us to understand spatial and temporal aspects related with Genotype-by-Environment (GxE) interactions. This information can be used to support geographic targeting of genotypes to environments. Wheat breeding and seed supply is dominated by the public sector. The socio-economic analysis focuses on the implications of our conclusions in Mexico in terms of public policies to ensure that farmers have access to seed of locally adapted wheat genotypes. Our cross-disciplinary approach that draws on plant physiology, crop breeding and socio-economics, provides a framework for policy-makers, researchers and development practitioners to identify where climate adaptation efforts should be directed. It is a framework that can be adapted to other regions and crops such as maize in sub-Saharan Africa.

Farming Adaptation to the Impacts of Climate Change and Extreme Events in Pacific Island Countries

V. Jese (1); J. Maeka (1); M. Wairiu (1)
(1) The University of the South Pacific, Pacific Centre for Environment and Sustainable Development, Suva, Fiji

Farmers in Pacific Islands’ communities are considered to be most vulnerable to the impacts of increased temperature, sea-level rise, droughts, cyclones, and heavy rainfall. Farmers in the Yaqui Valley, has shown that an increase of minimum temperature by one degree in the crucial growing period reduces yields by 10%. In order to assist crop breeding programs to select and target wheat genotypes, it is important to identify current and future agro-ecological zones for wheat production in Mexico and, subsequently, appropriate wheat genotypes for these zones. Already established networks for multi-environments trial evaluations worldwide (such as the International Wheat Improvement Network (WIN)) can be used to identify with our pre-calculated adapted wheat genotypes in order to recommend which ones could have greater impact in different agro-ecological zones in Mexico. This is particularly important to rain-fed areas of Mexico where scare information on genotype performance is available. To complement this approach, detailed studies on the same genotypes evaluated for physiological traits during different years can help to determine which specific traits confer to the genotypes an advantage under given environmental conditions.

We focus on appropriate climate adaptation strategies for wheat in rain-fed areas in Mexico. We use a bio-economic modeling framework involving crop, spatial and economic variables to identify "wheat hotspots" i.e. areas in Mexico which are particularly vulnerable to increased drought and heat stress. Drawing on data from international wheat trials at 25 sites worldwide, we identify wheat lines than could be released as varieties most suited to these predicted wheat hotspots. Additionally, combinations of crop simulation models together with geographic information systems (GIS) help us to understand spatial and temporal aspects related with Genotype-by-Environment (GxE) interactions. This information can be used to support geographic targeting of genotypes to environments. Wheat breeding and seed supply is dominated by the public sector. The socio-economic analysis focuses on the implications of our conclusions in Mexico in terms of public policies to ensure that farmers have access to seed of locally adapted wheat genotypes. Our cross-disciplinary approach that draws on plant physiology, crop breeding and socio-economics, provides a framework for policy-makers, researchers and development practitioners to identify where climate adaptation efforts should be directed. It is a framework that can be adapted to other regions and crops such as maize in sub-Saharan Africa.

Agricultural adaptation to climate change: assessing adaptive decision-making of Indian farmers

C. Jha (1)
(1) National Institute of Industrial Engineering (NITIE), Economics, Mumbai, India

Global climate change threatens natural and human systems and is expected to cause food insecurity, rural poverty, malnutrition and detrimental environmental conditions, especially for developing countries like India. Agriculture being the primary economic activity of developing countries, linkages between climate and agriculture are expected to be more prominent and vulnerable to erratic disturbances in near future. In this respect, adaptation is considered as a sustained approach to adjust agricultural system to changing climatic conditions. Agricultural adaptation involves local adjustments to climate variations and shifts in reducing production and income exposure to climate variations and extremes and ensures long-term resilience to future climatic turbulences.

Farmers being the key actors in agricultural sector; assessment of farmers’ decision making, their willingness to adapt, adaptive capacity and the likely responses to climate stimuli is crucial to ensure sustainable agricultural management. The critical question underlying farmer's responses is how do farmers decide when and how to adapt and what determines their ability to adapt. Farmers usually choose from a set of adaptation options such as crop diversification, crop switching, altering area under cultivation, managing crop sowing and harvesting timings, increased irrigation and soil and water conservation techniques; best suited to their local conditions. Farmers’ adaptation initially depends on their perception on changes in climatic conditions which are usually based on their past experiences of climate variability and extreme events and their future expectations of climate change which in turn is based on prevailing climate scenario. Although farmer’s perception to climate change might be a necessary condition it is not a sufficient condition to adapt as adaptive responses of farmers are finally determined by their incentive and ability to adapt. Farmer’s incentive to adapt is driven by their risk taking behavior and their expectations of earning sustained higher economic returns. Farmer’s ability to adapt might defer in terms of managerial and entrepreneurial capacities and farmer’s household and socio economic characteristics (Bryan et al., 2000; Nhemchena and Hassan, 2007; Deressa et al., 2008; Beddington et al., 2010; Fan et al., 2013). Indian farmers in developing countries usually try to maximize their net returns subject to their socio economic constraints, access to information and credit availability. Farmer’s decision making is often affected by complex set of socio-economic factors such as household size, age, gender, education level, off-farm income, farm size, access to extension services and credit availability etc. which are beyond farmer’s control.

Against this background, this study tries to hypothesize the possible effects of key socio-economic factors on ability of farmers to recover after disasters was dependent on their pre-disaster conditions, number and varieties of crops they had planted, type of cropping system in use, and consistent use of simple, traditional, and innovative adaptive techniques. Such techniques included crop rotations, change of planting and harvesting dates, and the planting of new resilient varieties.
conservation through crop switching and mixed farming practices. The magnitude of effects of these interlinked factors is however difficult to assess as it depends on socio-cultural, economic and political status which varies across spatial and regional scales and are often complex in nature especially for developing countries. The results of the study can be helpful in assessing vulnerability of farmer’s to climate change in developing countries and help in reducing barriers to climate change adaptation.

P-2224-12

Vulnerability assessment of commercial & small scale farmers to flooding and its impact on biodiversity from 1940 to 2010 in the Duiwenhoks and Goukou catchments Western Cape, South Africa

Z. Jonas (1)
(1) South African National Biodiversity Institute, Climate Change BioAdaptation, Cape Town, South Africa

South Africa is a water scarce country and the landscape and resources are unevenly distributed across the country’s landscape. The majority of the exploitable water is found in sparsely populated mountain catchment areas. Demands in terms of quality and quantity of water differ across sectors, water users and ecological requirements. For the Western Cape for example, a strong seasonality and micro-regional differentiation determines the balance between availability of water and the demands from water users. As a result the resilience of the impacts associated with water use are diverse in composition and intensity and affect the resilience of the province’s water resource situation and subsequent resource management. Major threats to both commercial and small scale farmers are as a result of water scarcity, which in turn directly affects the delivery of ecosystem services to the poor of the poorest. South Africa’s biodiversity and ecosystems are increasingly under pressure from accelerated climate change, ranging from temperature increases, changes in rainfall patterns and flooding. In Duiwenhoks and Goukou catchment there is evidence of increased floods from 1940 to 2010. This has resulted in degradation of catchment which compromises the delivery of ecosystem services that poor people depends on. The large parts of these wetlands are destroyed, and wetlands are good ecosystem services to prevent flooding and ensure good water quality. The major problem currently is the over-extraction of water for various activities within the catchments such as water for vineyard farms, dairy farming as well as commercial and small scale farmers. The vulnerability assessment data will be integrated with spatial data related to ecosystem services and development plans and others in order to assess who the existing spatial developments plans and integrated application plans can increase yields by 50%, as a bonus. Research in glasshouse trials suggests that this approach works and can increase yields by 50%, as a bonus.

P-2224-14

Reducing fungal infestations in growing groundnuts through biocontrol methods that can increase crop safety by deaerating Aflatoxin content

M. Kiffe (1)
(1) UKZN, Plant Pathology, Pietermaritzburg, South Africa

Peanut (Arachis hypogaea L.) is an important food crop in sub-Saharan Africa and also an important oilseed and food crop around the world. In most of sub-Saharan Africa, the consumption of peanut and peanut products is high because of their affordability and adaptability to a variety of culinary uses. Peanut consumption has been linked to the reduction of cardiovascular disease, type 2 diabetes, and heart disease. However, peanut is highly susceptible to the growth of mycotoxicogenic fungi and hence it is prone to aflatoxin contamination. Pre-harvest infection of groundnuts by Aspergillus spp. is of great food safety concern due to their ability to produce secondary mycotoxins, called aflatoxins. Aflatoxins cannot be readily removed from contaminated foods by detoxification. Members belongs to the genus Aspergillus are most abundant in the tropics and as such, are major food spoilage agent in warm climates. Therefore, there is a need to develop biocontrol methods that can increase the crop yield and reduce the infection of the groundnut seeds by these pathogens, and hence to stop the contamination of the seed by these toxins. Prior research in glasshouse trials suggests that this approach works and can increase yields by 50%, as a bonus.

P-2224-13

Influence of climate change on nitrogen-fixing bacteria and its use as bio-fertilizer for crop production

M. Karim (1)
(1) University of Dhaka, (and Global Young Academy), Microbiology, Dhaka, Bangladesh

Increasing rates of sea level rise in the mainland of the coastal areas of the Bay of Bengal is thought to have one of the many effects of climate change and global warming affecting developing countries of South Asia. Bangladesh, in particular has already been affected through land erosion and salinity intrusion in its broader coastline, and is expected to suffer further setback in the form of damage to infrastructures, crop failure, fisheries destruction and loss of biodiversity. The coastal area covers about 20% of Bangladesh and over 30% of the net cultivable areas. Such a vast area is feared to be affected with varying degrees of salinity intrusion, with the consequent reduction of normal crop production. This study attempts to isolate and identify agriculturally-important microorganism (AIMO), Azotobacter spp which play a predominant role in maintaining soil fertility. The results of the study can be helpful in assessing vulnerability of farmer’s to climate change in developing countries and help in reducing barriers to climate change adaptation.
Sustainable Agriculture: An ecosystem-based approach for climate change adaptation for food security – case study from an African Small Island Developing State

B. Lalljee (1)
(1) University of Mauritius, Agriculture and Food Science, Moka, Mauritius

Sustainable Agriculture as an ecosystem based approach for climate change adaptation for food security – case study from an African Small Island Developing State

Climate change is undeniably affecting all spheres of human life including food security. The impacts of climate change are felt more by the Least Developed Countries and small island developing states (LDCs), which have very fragile and unique ecosystems.

The ecosystem based adaptation (EBA) approach to food production and food security assumes greater importance in the LDCs, which have very fragile and unique ecosystems. The use of sustainable agricultural technologies represent one such EBA approach, and which includes measures such as mulching, minimum tillage, multiple cropping, use of soil conditioners such as compost, use of agroforestry systems, etc.

The project also included an important aspect of capacity building. Farmers were trained on compost making from agricultural and kitchen wastes, on the use of cover cropping, for weed and pest control, minimum tillage (time and frequency), soil and water conservation measures, rainwater and runoff water harvesting. The training also included an understanding of the barriers to EBA, in particular cultural traditions and practices, as well as an understanding of the ecosystem goods and services, ecosystem evaluation, as well as a lack of strong policy drivers behind EBA to climate change issues.

A stakeholder participatory approach was used, with the farmers, community leaders, and NGOs being actively involved right from the problem analysis stage. The project data and information together with farmer feedback at the end of the project, all stakeholders exhibited a strong positive sense of ownership of the results. The participants then served as ambassadors for the popularisation of this technology among peers, and has now been adopted by over 90% of the farmers in the community. This approach has a very high potential for replication in other SIDS as well as in the region. This project was funded by the European Union (EU) under the Decentralised Cooperation Programme (DCP).

Keywords: climate change adaptation, ecosystem based approach, mulches, tillage, compost, SIDS.
P-2224-17

Transhumant management in the context of climate variability in north east of benin

P. Lesse (1) ; J. Djentonin (2) ; I. Toko (3) ; M. Houinato (1)
(1) Faculty of Agronomics Sciences, Benin, Abomey–Calavi, Benin; (2) Faculty of Agromy, Parakou, Benin; (3) University of Abomey–Calavi, Abomey–Calavi, Benin

The W National Park and its surroundings are a privileged and concentration of the national herd where confront all the climate effects on the development of the transhumance. In context where the Benin suffers directly from weather conditions less under control, it is essential to improve knowledge on transhumance, know the current rangeland management and improve techniques. To achieve these goals, 300 breeders were maintained according to the quantitative and qualitative method based on a questionnaire and processed using the Sphinx plus2 software. The results we found that the texts on transhumance are outdated, ambiguous and unknown key stakeholders. Drought, high winds, excessive heat, late and heavy rain are the major weather risks affecting animals. In response to the new climatic conditions, large farmers practicing transhumance pastoralism opportunism traveling great distances. All surveyed farmers have noticed changes in their course. These changes may be due either to the plant populations on (80% of old corridor by burned crops (65%), the drying up a bit faster ponds and streams (32%). The effects of these changes between. It may be noted thereby lengthening the path of periods (65%), insufficient in water in other pastures (50%). The results allowed us to identify 12 transhumance routes in the neighboring municipalities of W Park, spatiotemporal dynamics showed that routes have also changed due to conflicts (68%). These changes are reflected in the reduction in grazing areas (58%), longer travel times (25%) and the emergence of new grazing areas (32%). The changes observed in the transhumance routes are part of the coping strategies of management breeders face the difficulties they face in feeding their animals. P-2224-18

Agriculture and conservation: agroforestry biodiverse systems as a adaptive strategy to climate change in the brazilian Atlantic Forest

G. Narezi (1) ; P.J. Sobral (2)
(1) Federal University of Southern Bahia, Center of Studies in Environmental Sciences, Porto Seguro – BA, Brazil; (2) Universidade do Porto, Research and Development of rural settlements and family farming, Piracicaba, Brazil

These analyses are focused on consensus possibilities regarding spatial planning solutions based on a perspective that overcomes the production/environment polarization and dichotomy. This study also found that transition to different agricultural models, which are more sustainable and biodiverse, can help family farmers achieve their goals. Thus, this research project is aimed at analyzing recent mediation strategies for social environmental conflicts, addressing issues like the access to land, natural resources and life quality in the context of the in the brazilian Atlantic Forest. The objective of this research is to develop an analysis on the technical and methodological innovations and applications, in particular to agroecological private and community production systems in these areas. The methodology adopted is based on bibliographic research and on the collection of primary data through field notebooks noting and oral reports gathering in participative spaces for use planning and land occupation in future rural settlements located in the southernmost region of Bahia, that has one of the largest continuous remnants of Atlantic Rainforest of the country. In addition, we are planning semi structured interviews with researchers who are working on themes related to adaptation and resilience in agricultural ecosystems regarding to climate change. The historical context of the region addressed in this research, including its economy cycles and social and environmental conflicts, must be considered. In the specific action of the proposal, up in negotiations between social movements, traditional indigenous populations, the state and forest companies are discussed here, in order to provide perspectives that enable an agricultural model that conserves the biodiversity of a massive part of the Atlantic Forest Brazil. This paper also reflects on the logic development of the transhumance. In context where the Benin suffers directly from weather conditions less under control, it is essential to improve knowledge on transhumance, know the current rangeland management and improve techniques. To achieve these goals, 300 breeders were maintained according to the quantitative and qualitative method based on a questionnaire and processed using the Sphinx plus2 software. The results we found that the texts on transhumance are outdated, ambiguous and unknown key stakeholders. Drought, high winds, excessive heat, late and heavy rain are the major weather risks affecting animals. In response to the new climatic conditions, large farmers practicing transhumance pastoralism opportunism traveling great distances. All surveyed farmers have noticed changes in their course. These changes may be due either to the plant populations on (80% of old corridor by burned crops (65%), the drying up a bit faster ponds and streams (32%). The effects of these changes between. It may be noted thereby lengthening the path of periods (65%), insufficient in water in other pastures (50%). The results allowed us to identify 12 transhumance routes in the neighboring municipalities of W Park, spatiotemporal dynamics showed that routes have also changed due to conflicts (68%). These changes are reflected in the reduction in grazing areas (58%), longer travel times (25%) and the emergence of new grazing areas (32%). The changes observed in the transhumance routes are part of the coping strategies of management breeders face the difficulties they face in feeding their animals. P-2224-19

Climate Warming and Rural Poultry Production in Southern Africa - A Review

N. Nyoni (1) ; S. Grab (1) ; VGE. Archer (2)
(1) University of the Witwatersrand, Geography an Environmental Studies, Johannesburg, South Africa; (2) CSIR, Pretoria, South Africa

Compared to other livestock types, poultry are more likely to be owned by most rural households in developing countries. Rural poultry production is characterized by small scale and substantial contribution to household income. However, rural poultry production challenges, and climate warming and poultry production is reviewed, and key knowledge and data gaps identified. Researchable issues on climate warming and rural poultry production are further suggested. P-2224-20

The Important of Preservations and Distribution of Milk in respect to the Different Weather Changes in Federal Capital Territory Areas of Abuja, Nigeria

M. Oke (1)
(1) Michael Adedotun Oke Foundation, International Development, Federal Capital Territory, Nigeria, Federal Republic of

This paper look at the important of the preservation and the distribution of milk in respect to the different weather, during the dry and wet seasons and how does it affect the level of consumption, tases, marketing strategies, mode of preservation and the different methodology being use in preservation. The result is also showing the problems being encountered in the process. The research was conducted in two areas council of the Federal Capital Territory namely Cwaregalawa and the Municipal . The findings show that what was common is the lack of milking in taste level of consumptions of an individuals that consumes it, it have impact in the areas of transportation during the rainy seasons most Fulani’s women finds it difficult to move the milk away because of the snows roads in most of the rural areas , cost price, the level of milking of animal is high in the rainy seasons due to the much of grasses and indirectly affect the rate of measurement, cost reduces in getting ice blocks for preservation of the milk and during the raining seasons.
Grape growing: a symbolic marker of climate evolution and a model to study adaptation

N. Ollat (1) ; I. García De Cortazar-Atauri (2) ; C. Van Leeuwen (3) ; E. Duchêne (4) ; P. Pieri (1) ; H. Quenol (5) ; B. Labbé (6) ; F. Geindre (7) ; J. Desprez (8) ; J. M. Camps (9) ; J. P. Goutouly (1) ; H. Ojeda (9) ; L. De Rességuey (10) ; E. Neethling (7) ; J. M. Boursiquot (10) ; J. M. Touzard (11)

(1) INRA, EGFV, Villeneuve d’Ornon, France; (2) INRA, Agroclim, Avignon, France; (3) Bordeaux Sciences Agro, Egv, 33400 Blagnac, France; (4) CNRS,LEMA, Montpellier, France; (5) INRA, Oenologie, Toulouse, France; (6) Université de Bourgogne, Centre de recherches de climatologie / biogéosciences, Dijon, France; (7) INRA, UVR, Avignon, France; (8) LMA, Montpellier, France; (9) INRA, Domaine de pech rouge, Cruissian, France; (10) Montpellier Supagro, Agap, Montpellier, France; (11) INRA, Montpellier, France

Grapevine has been domesticated 8 to 10 000 year ago in Eurasia. From there, grapevine growing and wine making expanded to the European–Asian–North African continents, and more recently to the so-called “new world”. It is still one of the major high value fruit crops in the world. The capacity of this crop to colonize new lands and climates since ancient periods, facing a full range of climates, demonstrates its ability to adapt to various climatic conditions. In traditional growing zones, cultivars and human practices have been selected in order to take the most of natural resources by adapting the grapevine to specific environments or unique wines. The balance between environmental conditions, cultivars and management practices within a specific location, referred to as the “terroir” concept (according to OIV definition), is used to market wines and increase their economic value. However current climate change may endanger this equilibrium. Considering these aspects, grape and wine industry may be considered as a model to study climate change. The scope of a French project, named Laccave reported hereafter.

The close link of grapevine phenology with climate is demonstrated through successful reconstruction of past climate trends from harvest dates. Several studies show that process-based phenological models can accurately be used to calculate past temperatures and detect anomalies. Additional information on cultivars, wine styles and produced wine quality as well as viticultural practices in different wine regions may help to build more robust models at local scales. Phenological models have also been used to assess the future growing conditions by using climate simulations. For example, these studies show that an advance of 30 to 40 days for major phenological stages may occur at the end of the 21st century. Consequently, most varieties are expected to ripen at increasingly warmer conditions, impacting fruit composition and wine types elaborated from these grapes.

These changes are already noticeable in existing vineyards with a recorded advance of 2 to 3 weeks for harvest dates over the last 20 years. Increased sugar contents, lower acidity levels and modified aroma and polyphenolic composition have been observed. The suitability of actual growing zones may be seriously affected in the future and new sites may become appropriate. Cultivated areas in Great Britain have more than doubled in 25 years and vines are now grown in Sweden and Poland. Nevertheless the concept of suitability has to be taken with caution and large scale studies can lead to erroneous conclusions for local situations. Local climatic variability, adaptation of cultural and oenological practices and plasticity of cultivars may enlarge the limits of suitability. An international study is on the way to characterize and model the thermal variability at local scale within grapevine growing regions in order to define the parameters of climate variability and the most suitable areas for the future.

It is clearly shown that local temperature variability within growing areas can be in the same range as variability between regions or several years and have to be taken into account for defining the adaptation strategies. Altitude and exposition are key parameters. In each location, most suitable varieties to new climatic conditions can be chosen among traditional ones, but also within the large diversity existing among Vitis vinifera spp cultivars. Rootstocks bred from a larger range of Vitis spp background may also contribute to adaptation. Cultural practices such as canopy or soil management need to be taken into account as well as local variations in site conditions. Irrigation can be an answer to severe water deficits but in the long run competition for water resources and increased soil salinity may become major problems. Alternative water sources, as retreated water, can be considered, but they have to be adapted to the environment and on wine quality have to be considered. Other disruptive innovations have to be invented. Growers and actors need to be associated to the process of defining strategies. The organization of innovation dissemination within the industry are key issues in this approach of adaptation. The research conducted within the Laccave project participates to the definition of these strategies and describes the mutual contribution of human and natural resources. It will be presented, based on examples from French vineyards.
This study focused primarily on the different actors involved in the rice production in Tonga (Western Cameroon) and strategies set to boost its cultivation, and it brought up some suggestions to the various problems that tend to weaken the activity. Preserving and enhancing food security requires agricultural production systems to increase productivity and to reduce output variability in the face of climate change and other agro-ecological and socio-economic risks. Cameroon, a low-income food-deficit country, has made agriculture a focus of its development. But the 2007’s riots, coupled with the food prices soaring, deeply raise the double problem in the fight against food insecurity and poverty. The objective was to investigate the role played by the rice-growing activity in Tonga in the fight against food insecurity and poverty. Rice production in Tonga is on the rise because of its natural assets and good quality of the rice cultivated in the locality. To test this hypothesis, we used Quivy Campenhoudt and Van (2006) and Thièart (1999) methods ranging from field investigation (enquiries to relevant stakeholders, on-the-spot assessment), sapping and computerization of data. These methods have demonstrated that rice-growing contributes about 80% to the fight against food insecurity and alleviate poverty in Tonga. These findings could contribute to the improvement of the living conditions of rural populations in Tonga. However, to reverse the trend of rice consumption in Cameroon overall, it is necessary to move from family/traditional farming to industrial/modern agriculture on which the population could sustainably rely to improve their living conditions. The Cameroonian government through the Agricultural Sector Development Program (PADFA) provides different supports to farmers to eradicate hunger and poverty, and finally ensure a brighter future for rice growing. New challenges and technological opportunities for rice-based production systems for food security and poverty alleviation are then needed.

P-2224-25
Screening of Blackgram (Vigna mungo (L) Hepper) genotypes for thermo-tolerance using Temperature Induction Response (TIR) technique

C. Tchieudjo (1)
(1) the University of Yaounde I, the Faculty of Arts, Letters and Social Sciences, Department of Geography, Yaounde, Centre, Cameroon

This study focused on-farm diversification to manage climate risks and improve food security in coffee landscapes, there

P-2224-26
Does diversification in smallholder coffee landscapes help farmers to adapt to climate change? Answers from Nicaragua

M. Van Zonneveld (1); R. Guevara, (1); A. Fallot, (2)
(1) Bioversity International, Turrialba, Costa Rica; (2) Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD), Turrialba, Costa Rica

Introduction: The Central American coffee production area is predicted to reduce substantially under progressive climate change. The livelihoods of many smallholders in these landscapes are threatened because they largely depend on coffee cultivation. Despite the growing emphasis on on-farm diversification to manage climate risks and improve food security in coffee landscapes, there
are no criteria developed to quantify the status, need and outreach of diversification.

Objectives: We identified with community representatives and other local stakeholders in two contrasting coffee zones in Nicaragua (dry and humid): 1) the role of on-farm diversification in farmer strategies in climate change adaptation; 2) different dimensions of on-farm diversification; and 3) the need for specific measures to make use of the potential of diversification.

Methods: We carried out a literature review highlighting the different dimensions of diversification, and for each dimension, the benefits and drawbacks of diversification for smallholders of coffee landscapes. We consulted institutions and focal groups from ten communities in two contrasting coffee zones in Nicaragua: 1) the yield stability of their livelihoods to climate changes; 2) existing and desirable strategies to adapt to these changes; 3) existing diversity in coffee farms; 4) what on-farm diversification would represent for them to be an effective way of adapting to climate change. Taken into account the gender issue, we conducted interviews in farm households to understand how actual diversification is related to climate risk management and food security status, and to identify specific needs to enable farmers making use of the potential for diversification. To embed our results in local development and research processes, our activities were linked to existing farmer initiatives and the local university agronomy faculty. In each coffee zone, phenological calendars for the principal crops were developed on the basis of the collected information to support farmers’ crop management under the existing climate variability.

Preliminary results and discussion: Farmer families in both coffee zones indicated crop diversification among adaptation options that they prefer, particularly enrichment with fruit perennials like plantain, banana and citrus. These crops provide cash flow through the year and can be used also for own consumption to enrich the diets of farmer families. Though a large diversity of agricultural species is grown in the landscape, most on-farm activities are concentrated around coffee, maize and common beans and take place between May and August, which coincides with the months of seasonal hunger. This suggests a high potential for diversification which is currently little utilized to improve food security, generate income and to adapt production systems to climate variability. The literature review allows us to draw a first typology of complementarity and competition effects among crops. Some farmers have already enriched their coffee farms with fruit perennials and other crops. Because of their experience, they are key persons to share knowledge about benefits and risks of crop diversification with other farmers. At landscape level, farmers stressed the importance of sufficient tree cover to ensure key environmental services like water availability. Restoration and conservation activities at landscape level will require coordination among farmers and governmental organizations.

Acknowledgements: This study is financed by the PCP Research Platform and CCAFS.

2225 Climate Smart Agriculture: Propaganda or Paradigm Shift?

ORAL PRESENTATIONS

K-2225-01 From a global science conference towards UNFCCC negotiations: mobilizing science for transitions

P. Caron (1)
(1) Cirad, General direction, Montpellier

This presentation aims at presenting the main out come results from the Conference of the Global Science Conference on Climate Smart Agriculture (CSA) in Montpellier, France, 16 – 18 March 2015 where more than 600 researchers and 150 stakeholders and policy makers from 75 countries and 5 continents converged. CSA is a framework that mobilizes synergies and can lead to innovative and comprehensive solutions at local, regional and global levels. Delegates also confirmed that CSA solutions exist and can be brought into reality provided favorable conditions.

Agriculture was acknowledged as a sector particularly vulnerable to climate change, which impacts the livelihoods of the world's poorest people. This places increased strain on global food systems, especially since expectations for meeting demand for food will change tremendously within the next 40 years. Agriculture has also a central role to play in ensuring green economic growth, and emissions therefore at the heart of complex challenges to be addressed. CSA invites researchers, practitioners and policy makers to explore solutions combining three pillars, food security, climate change adaptation and mitigation, underpinning sustainable landscapes and food systems. This is essential since the sector is facing unprecedented uncertainty and risks: synergies have to be looked at and trade-offs addressed. Recognizing that agriculture is a pivotal sector for international negotiations on sustainable development and climate change, CSA therefore provides a framework for looking at necessary transitions.

The main recommendations were as follows: (i) agriculture in the future must also address the challenges of sustainable food systems and landscapes; (ii) based on a renewed research agenda that addresses a more complex set of objectives, researchers and practitioners must engage to build evidence and design the trajectories for multiple transformative transitions of climate-smart agriculture; (iii) the future relies upon policy, institutional and financing decisions and particularly upon the involvement of policy and development agencies, civil society and the private sector with researchers and research institutions in innovation platforms.

The strengthening of CSA scientific community must be pursued and better engaged in interfacing with policy makers, promoting scientific diplomacy. Their capacity to develop relevant global research programs and joint initiatives to address as from now questions that will be key in the future should be supported and stimulated through international cooperation platforms.

K-2225-02 Decision-support framework for targeting investment towards climate-smart agriculture practices and programs

A. Nowak (1); C. Corner-Dolloff, (1); AM. Loboguerrero, (2);
M. Lizarazo (2); F. Howland (1); N. Andrieu (3); A. Jarvis (1);
(1) International Center for Tropical Agriculture (CIAT),
Decision and Policy Analysis Research Area, Cali, Colombia;
(2) CGIAR research program on Climate Change, Agriculture,
and Food Security (CCAFS), CCAFS latinamerica, Cali,
Colombia; (3) Centre de Coopération Internationale en
recherche agronomique pour le développement (CIRAD),
L'unité mixte de recherche innovation et développement
dans l'agriculture et l'agroalimentaire, Montpellier, France

Unprecedented impacts of climate change on agricultural systems around the world coupled with increasing food demand underline the urgency of building a more productive, resilient, and low-emission agricultural development model – one that is climate-smart. Establishing climate-smart agriculture (CSA) systems requires investment in concrete on-farm practices and broader programs to establish implementation at scales that will transform systems to address food security and development goals in the face of climate change. The
The adoption of Climate Smart Agriculture innovations: a summary of an EU project

V. Blok (1); T. Long (2)

(1) Wageningen UR, Mst, Wageningen, Netherlands; (2) Wageningen UR, Mst, Wageningen, Gelderland, Netherlands

Agriculture and its supply chains will be profoundly impacted by actions to mitigate against, and adapt to climate change. The emerging concept of Climate Smart Agriculture (CSA) is one response to this challenge, involving the simultaneous increasing of agricultural productivity and incomes, adaptation and the building of resilience, and the reductions of GHG emissions (FAO, 2010).

Whilst heavily advanced within developing country contexts, CSA is also forming a strategic priority within Europe. Technological innovations are signalled as playing a critical role in the transition towards CSA. However, the diffusion of technological innovations within OECD countries has been slow (del Rio González 2005). This is due to the presence of social and economic barriers, including poor market incentives and low levels of awareness.

The development and refinement of appropriate business models for CSA, increasing awareness and the alignment of national and EU policies have been highlighted as responses to enhance the transition to CSA.

Results from a Climate KIC pathfinder project on CSA will be presented during this key note talk. This ongoing project seeks to increase the adoption and diffusion of CSA technological innovations across the EU by stimulating both supply and demand. The presentation will provide an overview of the projects approach and results to date, which will include consideration of:

- The role and form of inhibiting social and economic factors.
- The role of business models in enhancing CSA technologies, and identifying critical issues that shape successful CSA business models.
- Current policy and regulatory impacts, and how these could be altered in the future to further the diffusion of CSA technologies and practices.

The development of services to boost CSA in Europe.
rainfall and temperature trends as well as effective water use strategies (supplemental irrigation) in areas of deficit rainfall are recommended to ensure food security and sustainable livelihoods in Nigeria.

P-2225-02

Salinity a Deleterious Impacts of Climate Change: Biochemical and Physiological indicators of adaptation of Vicia faba L. to Salt Stress

F. Anaya (1); R. Fghire (1); S. Wahbi (1); K. Loutfi (1)

(1) Faculty of Science Semlalia, University Cadi Ayyad, Biology/Laboratory of Biotechnology and plant physiology, Marrakech, Morocco

Plant physiological processes are invariably linked to the deleterious influences of climate change. Salinity stress is considered as one of the major abiotic stresses which strongly reduced crop productivity. In order to assess the effect of salinity constraint on some physiological and biochemical traits in broad bean (Vicia faba L.), two cultivars (Extra Hative and Lobab), originated from Morocco, representatives of two climatic zones were evaluated for their response to salt stress. In this study, the biochemical and physiological responses of two salt stresses levels (0 and 150 mM NaCl) on V. faba L. and the effect of exogenous salicylic acid (0.5 mM) at 150 mM salt stress were investigated. The irrigation with salt water (150 mM NaCl) was applied after 15 months of sowing for 21 days. The biochemical and physiological characteristics of Vicia faba L. were measured including: leaf water potential, stomatal conductance, membrane permeability, chlorophyll content and antioxidant activity (PPQ, POD, and SOD). The results showed that the physiological and biochemical parameters were affected by salt concentration and there were varying responses between varieties. Thus irrigation with salt water significantly reduced plant growth performance of membrane permeability. However salt stress caused an activation of oxidative enzymes (PPO, POD and SOD). The increasing of the antioxidant activities was significantly (p<0.05) correlated with salt stress. These results suggest that antioxidant enzymes play an important role in reducing oxidative stress in the broad bean exposed to salt stress. Nevertheless the protein and chlorophyll content showed an increasing with salt stress. All the biochemical and physiological parameters in comparison to the respective control. Indeed, Salinity affected leaf water potential, Stomatal conductance and membrane permeability. However salinity negatively affected growth parameters, although selection of tolerant cultivars is a viable solution as the case of Extra hative in this study.

P-2225-03

Fostering Climate Smart Agriculture : what role for voluntary sustainability standards?

G. Balineau (1)

(1) Agence Française de Développement, Paris, France

Greenhouse gas emissions are seen by economists and others as negative externalities of production (and, to a lesser extent, trade). In this context, two ways of regulating "environment" are generally considered for public action: "command-and-control" orders (that is to say legislative or compulsory regulation) and/or "market-based" instruments (for example creating a market for pollution rights). However, a "third wave of regulation" (Tietenberg, 1998, "Disclosure strategies for environmental information" Risk and Environmental Economics, 11, 587–602) has emerged since two or three decades, based on information provision. This is especially the case in agriculture, where smart consumers should be able to make informed choices (by acquiring "accurate voluntary sustainability standards") such as "carbon free" or "environmental-friendly" assertions, which have proliferated since the 1990s are part of this third wave of environmental regulation based on information provision. Which one be their role in mitigation and adaptation to climate change? How can we paradoxically solve production externalities through the so-called "responsible" consumption while consumers should be rational and free ride when they are told to contribute to common or public goods? To assess the efficiency of eco-labels in contributing to mitigation and adaptation challenges, we have to answer 3 questions:

• First, do eco-labels explicitly include the objectives of mitigation and adaptation to climate change? Studying charters and standards for forest-based products and cocoa, we show that mitigation criteria are almost systematically included in eco-labels standards, whereas this is clearly not the case for adaptation ones.

• Second, why should eco-labels be successful in inducing consumers' behaviors change when regulation-based and market-based instruments failed? We show that there are two hypotheses behind the efficiency of labels: i) consumers are willing to pay for contributing to common or public goods and ii) labels solve two types of uncertainty: as salience: the first is an asymmetry of information "a la Akerlof" [Akerlof, G. A.: 1970, "The Market for "Lemons": Quality Uncertainty and the Market Mechanism", Quarterly Journal of Economics 84(3), 488–500], the second is an uncertainty "a la Darby and Karni" [Darby, M. and E. Karni: 1973, "Free Competition and the Optimal Amount of Fraud", Journal of Law and Economics 16(1), 67–88]. Research show that i) consumers are willing to pay for common goods, ii) asymmetry of information about the respect of standards is not a problem but high uncertainty about the efficiency of standards (i.e. what criteria should eco-labels include) is still prevalent.

• Third, labels should not create new externalities or perverse effect, which could be the case if; for example, consumers do not consider the impact of their aggregated consumption but only by units consumed.

As a conclusion, we draw the lessons in terms of possible action for donors and public powers.

P-2225-04

Assessment of the olive tree adaptation to water stress and tool to increase crop performance in the context of climatic changes

D. Boujnah (1)

(1) Institution de la Recherche et de l'Enseignement Supérieur Agricole, Institut de l'Olivier, Sousse, Tunisia

Global climate change will introduce substantial changes to the agricultural ecosystems and consequently will affect the agricultural productivity. Water stress is the most important factor limiting plant growth and production. Thus, monitoring of plant water status in field grown is considered of great interest; as it would allow the diagnoses of the onset and severity of water stress so as to optimise the cultural practices according to the actual plant needs. Changes in plant water status could be described by using a sensitive physiological indicator, which integrates both soil and climatic conditions. The aim of our study is to evaluate a quantitative direct relationship of the olive tree water status and the environmental conditions that might be used to evaluate the response of the tree to some unconventional cultural practices: use of hydro absorbent, increasing plantation density and supplement water of traditional olive tree grove. For online control two techniques was used: the sap flow measurement system and the leaf patch clamp pressure probe (LPCP) which give information about the relative changes in turgor pressure (Ps) of the monitored plant.

The results of the sap flow measurement showed the direct influence of changes in environmental factors, water state and the physiological parameters of the tree on the sap flow level among the olive tree. For the LPCP the instantaneous data, provided by the probe, have allowed us to have an accurate information on the hydraulic behavior of the olive tree and the adjustment of the hydro absorbent in the soil to enhance the effect of the available water. Indeed, we found that the effect of the water provided by the hydro-absorbent doesn't act directly on the olive trees as is the case of direct water supply, its effect is delayed for a few days. This product can be used effectively to support the
ABSTRACT BOOK

ABSTRACT BOOK

varieties to each of the farmers to be grown alongside their selection (pVs) trials, comparing with current varieties. in wheat, the farmers of Bihar and Uttar pradesh were marks from the farmers by a fresh set of varieties. sensors. every season, we repeat the process with a new their neighbours to evaluate these varieties. We also record (15-20 varieties) and varieties currently grown in the area introduced varieties as per the farmers’ verdict of different pests and diseases. at the end of the season these data Farmers rank these 3 varieties evaluating various packages to avoid any bias based on previous knowledge or comparisons with neighbours during the crop cycle. We ask farmers 8–9 questions about their preferences. Farmers rank these 3 varieties evaluating various characters such as germination, yield, and resistance to pests and diseases. At the end of the season, the data is compiled to see the overall performance of these newly introduced varieties as per the farmers’ verdict of different characters. We also did a set of carefully managed on-farm trials with a quantitative evaluation of the full varietal set (15–20 varieties) and varieties currently grown in the area for agronomic performance. One or two of these trials are done per village and managed by leader-farmers who invite their neighbours to evaluate these varieties. We also record local weather conditions by using low-cost meteorological sensors. Every season, we repeat the process with a new set of varieties as we replace the varieties that received low marks from the farmers by a fresh set of varieties.

In wheat, the farmers of Bihar and Uttar Pradesh were growing only two varieties, Up 262 and pBW 343. Our evaluation data with the meteorological data to generalize its effects on different aspects of today’s world. Climate change affects crop production directly through the intensity and frequency of different types of stress, such as drought, heat stress, and flooding. One important adaptation measure is that farmers change to new varieties and crops. To make these changes, farmers first need information about new options and how they perform on their farms. This requires a massive effort in creating new information about crops and varieties in different contexts that is difficult to achieve with current approaches. Our work uses a novel citizen science approach to create the citizen-science initiative that started in 2012 in the Indo Gangetic Plains of Bihar and Uttar Pradesh in India with rice and wheat. Since then, the approach has also been applied in Eastern Africa and Central America. This presentation focuses on India, where the application of the citizen science approach has advanced most.

The citizen science approach uses the farmers’ views and preference in a participatory way using crowdsourcing to look for the best set of genotypes that can perform well under the changed climatic conditions of India. We first introduced several 100 varieties released from the National Agricultural Research System (NARS), selecting 12–20 varieties in each site through Participatory Varietal Selection (PVS) trials, comparing with current varieties. For this, we compared different combinations of 3 varieties to each of the farmers to be grown alongside their own regular crop. The variety names are not marked on the packages to avoid any bias based on previous knowledge or comparisons with neighbours during the crop cycle. We ask farmers 8–9 questions about their preferences. Farmers rank these 3 varieties evaluating various characters such as germination, yield, and resistance to pests and diseases. At the end of the season, the data is compiled to see the overall performance of these newly introduced varieties as per the farmers’ verdict of different characters. We also did a set of carefully managed on-farm trials with a quantitative evaluation of the full varietal set (15–20 varieties) and varieties currently grown in the area for agronomic performance. One or two of these trials are done per village and managed by leader-farmers who invite their neighbours to evaluate these varieties. We also record local weather conditions by using low-cost meteorological sensors. Every season, we repeat the process with a new set of varieties as we replace the varieties that received low marks from the farmers by a fresh set of varieties. That they like and find superior to the ones that they were already growing. The farmers also provided in previous years, the seeds of these selected varieties and a number of groups are now producing and selling seed. Sales by farmer groups will help to make it financially sustainable to continue the introduction, testing and marketing of new varieties and adapt to new climatic conditions.

Managing the biological function of N2O reduction for mitigating soil N2O emission

C. Henault (1); JPA. Cohan (2); GC. Le (3); M. Bardy (4); X. Gallegue (5); R. Philippon (6); C. Revellin (7)

(1) INRA, UR SOLS 0272, Orleans, France; (2) Agropolis, Ferme expérimentale de la jaillère, la Chapelle saint sauveur, France; (3) CETIOM, Thiverval Grignon, France; (4) INRA, Us infosol, Orleans, France; (5) Université Orleáns, Laboratoire d’économie d’Orléans, Orléans, France; (6) Agropithiviers, Pithiviers, France; (7) INRA, Agroécologie, Dijon, France

Human activities are currently considered to emit 5.3 Tg N2O per year, mainly from agriculture that accounts for around two-thirds of these emissions (UNEPI, 2013). The atmospheric gas N2O is involved both in the greenhouse effect with a contribution on a molar basis of around 300. The efficiency of soils to reduce N2O to N2 is highly variable. Soils with low N2O reduction potential have also been observed to emit high levels of N2O on a field scale (Hénault et al. 2005). We developed strategies to mitigate N2O emissions from agricultural soils in order to stimulate the microbial process of reduction of N2O to N2. We therefore developed two different approaches for promoting the biological reduction of N2O in soils.

The first one, is based on the results previously obtained by Sameshima-Saito et al., 2006 who had observed that Soybean roots nodulated with Bradyrhizobium japonicum USDA110, carrying the nosZ gene, were able to remove low concentrations of N2O. We studied the consumption of N2O by strains of Bradyrhizobium japonicum (USDA110 and M5DJ C49) on inoculated soybean plants cultivated in soil pots during a greenhouse experiment. During this experiment, we switched from a system acting as an N2O source (soil + soybean inoculated with nosZ gene deleted strain) to a soil N2O sink (soil + soybean inoculated with strains carrying the nosZ gene). Calculations using the obtained quantitative results clearly suggest an environmental benefit of nosZ+–nodulated leguminous on the field scale, with an assessed abatement of field emission of 60% during the investigated period, (Hénault and Revellin, 2011).

The principle of the second approach is to understand the physico-chemical determinism of the N2O reduction in soils and then to manage these conditions to promote N2O reduction. Around 100 soil samples of the RMQS, the French Soil Quality Network, were sampled and analysed for determining their physico-chemical conditions associated to their capacity to reduce N2O into N2. Soil pH was observed as an essential determinant of the capacity of soil to reduce N2O, this capacity increasing with soil pH. A field experiment was then set up on an acidic soil, receiving calcareous amendment. We observed a pH increase followed by an increase of the soil capacity to reduce N2O and at the same time a reduction of soil N2O emissions at the field scale, with an observed abatement of field emission up to 50% during the investigated period.

The management of the biological reduction of N2O into N2 appears possible both by biological (inoculation of leguminous crops by strains having a functional nosZ gene) or physico-chemical (pH management) actions. A stimulation of the function of the denitrification processes is a promising approach for mitigating soil N2O emissions. These both approaches are very interesting because they don’t create any transfer of nitrogen pollution in environment and because they do not compromise agricultural production of proteins.
These studies are supported by the ADEME (SOLGES project), the Conseil Regional Centre Val de Loire (PUJIES project) and the Labex Voltaire (ANR–10–LABX100–01).

P-2225-07

Climate Smart Adaptation on Lake Kariba: A Case Study of Siavonga District

M. Kabisa (1)
(1) University of Zambia, Geography and Environmental Sciences, Lusaka, Zambia

Siavonga district has for the last two decades experienced declining, unpredictable and poorly distributed rainfall and experiencing climate change impacts. Climate impact studies on Lake Kariba Kapenta fish stocks show increased temperature and reduced rainfall are the main climatic factors affecting fish catch. This has led to reduced primary productivity, fish productivity and resulted in reduced Kapenta fish catch. These studies however, have not considered resource users perceptions and their adaptation to climatic variability and change.

The adaptation strategies of Kapenta fishers to climate variability and their perceptions were investigated in Siavonga district, using primary data collected by a structured questionnaire, interview schedule and secondary data. A random sampling technique was used to select 60 Kapenta fishers on Lake Kariba. Descriptive statistics, Multiple Regression Analysis, Pearson Correlation Coefficient and a Likert scale were used to analyze the data collected.

Strategies employed by the Fishers to adapt to impacts of climate variability included no adaptation (9.5%), shifting fishing times (28.8%), shifting fishing locations (10.6%), changing fishing gear (6.5%), or catching smaller fish (12.3%). Alternative livelihoods (5.5%) and ‘Other’ specified options (6.8%). An R2 value of 0.195. Multiple regression analysis showed that temperature (0.273 and 0.066, which are below 0.3, indicating a small strength of correlation. They had a range of values between 0.273 and 0.066, which are below 0.3, indicating a small strength of association.

P-2225-08

Revamping Agriculture Sector through Sustainable method: Using Solar Water Pumps in Punjab state (Study of selected Districts)

R. Kaur (1)
(1) Panjab University, Public Administration Department, Mohali, Punjab, India

Abstract— Sustainable agriculture is the activity oriented concept to produce food in a suitable quality and quantity and guarantee food security for the world. Land use, crop choice, irrigation, and fertilization should be done in such a way that it should not lead to land degradation and desertification. India’s irrigated agriculture sector plays a significant role in India’s economic development as 28% of India’s GDP and 67% of employment is based on agriculture. The reliable irrigation is a critical demand as farmers in India are facing issues like erratic grid supply, increasing unreliability on monsoon rains and high cost of diesel pumps. The availability of less than 1000 cubic metre per capita is considered as scarcity as per International Standards and remedial measures. Government of India at union level and State Governments had formulated certain policies and programmes to overcome this issue and have implemented SWP schemes for improving irrigation system to increase production of food grain.

An attempt will be made through this to analyse need and scope of the implementation of SWP scheme in state of Punjab for sustainable irrigation to increase crop production. The main objective of the study is to evaluate the extent of scheme implementation and strategies employed, by farmers to adapt to impacts of climate variability on the catch and use a variety of strategies depending on which option is available at the time.

The respondents noted that there were constraints to adapting to climate variability. A total of 66 (82%) of the adapting fishers stated that they faced some difficulties in adapting. Of these, 48 respondents (60%) cited a lack of money as being the main constraint to adaptation and 24 respondents (30%) cited other reasons.

A total of 79 Kapenta fishers (87.7%) were aware of climate variability. In terms of the amount of rainfall in the district, 44 respondents (49.2%) perceived a decrease and 25 respondents (27.9%) perceived an increase. In terms of temperature, 31 respondents (34.4%) stated there was an increase and 10 respondents (11.5%) perceived a decrease. About 15 respondents (16.4%) perceived an increase in Kapenta catches and 53 respondents (59%) perceived a decrease in catches. The Regression model gave an R2 value of 0.195. Multiple Regression analysis showed that Age (p = 0.01), Years of Fishing Experience (p = 0.024) and Access to Extension services (p = 0.054) have the most significant relationship with perceptions as well as having the highest Beta values contributing to perceptions to climate variability. Pearson correlation coefficients showed that the independent variables are not highly correlated. They had a range of values between -0.273 and 0.066, which are below 0.3, indicating a small strength of association.
overall district level strategy for enhancing the adaptation and productivity. Currently, the toolbox has a limited scope and contains a wide variety of approaches. This could happen, for instance, through alterations of the land tenure and land taxation system at the national level, enhancement of the extension system, knowledge and input at district level, and by supporting a less complex governance structure at village level.

P-2225-10

Tropical climate-smart soil conservation technologies for agro-ecosystem resilience

S. Mesele (1); H. Ej (1); A. Jo (2)
(1) International Institute of Tropical Agriculture, West Africa, Accra, Ghana; (2) Federal University of Agriculture, Oyo State, Nigeria, Federal Republic of.

Enhancing resilience in ecosystem changes for improved agro-ecosystem services is a prerequisite for sustainable land management. Sustainable land management in the context of climate change presents great potential for protection and enhancement of ecosystem services in all land use systems. The degradation of water, soil and vegetation, as well as greenhouse gas emissions contributing to climate change can be significantly abridged by climate-smart soil conservation technologies that simultaneously conserve natural resources and increase crop yields. The diverse climate-smart soil conservation technologies are however scattered and poorly documented in the literature with varying levels of adoption among the smallholder farmers who are the backbone of tropical agriculture. This paper therefore reviews different soil conservation technologies that have been found effective in different agro-ecological zones, and with the capacity to enhance resilience in tropical agro-ecosystems. The technologies were grouped into improved farming system technologies, soil cover/residue management technologies, cropping system technologies, soil management technologies, soil fertility amendments technologies, and mechanical field technologies. The need for further research, extension and appropriate policy formulations on these technologies were further highlighted.

P-2225-11

Climate-smart agriculture and cocoa: engaging with farmers and their supply chains in Ghana

S. Mulerman (1); C. Bunn (2); H. Kirsch, (3); L. Jassogne (4); M. Lundy, (2); P. Läderach (5); P. Van Asten (4); G. Schroth, (6); R. Asare, (1); NA. Anyidodo, (7)
(1) International Institute of Tropical Agriculture, West Africa, Accra, Ghana; (2) International Center for Tropical Agriculture, Cali, Colombia; (3) International Institute of Tropical Agriculture, Yaoundé, Cameroon; (4) International Institute of Tropical Agriculture (IITA), System Agronomy, Kankula, Nigeria; (5) International Center for Tropical Agriculture (CIAT), Ciat - asia, Hanoi, Vietnam; (6) Rainforest Alliance, Dapaong, Togo; (7) University of Ghana, Institute for Statistical, social and economic research, Legon, Ghana

Global demand for cocoa has been increasing 2–3% annually, especially due to growing demand in Asia. The cocoa industry is challenged to produce the additional million tons required over the next years. The historic growth model for cocoa, especially in the Upper Guinea Rainforest areas, was largely based on successive waves of migrant cocoa farmers moving into virgin forests. With less than 15% of the original forest cover remaining in West Africa, this model has collapsed. Recent studies have revealed that cocoa cultivation further threatens the current production zones, negatively impacting production if nothing changes. Sustainable, profitable and climate-smart intensification is required, not only to sustain the global industry, but also the livelihoods of its smallholder producers. Previous recommendations to improve productivity, including full–sun or low shade intensified cocoa, today apply to an ever-decreasing group of cocoa producers who have the necessary resources for this type of farming; moreover, it may increase the vulnerability of cocoa farmers to climate change. Availability and access to the right agro–inputs is necessary but insufficient to promote farmer’s adaptation to climate change. Productivity has been achieved especially in Ghana’s last cocoa frontier, the Western Region, which has been the prime focus of vast government subsidy and distribution schemes. However, adaptation to climate change could not sustainably be scaled to a national level. This is also clearly demonstrated by the persistence of a 50 to 75 percent yield gap for cocoa under on-farm compared to on-station conditions. Climate-smart cocoa initiatives will not only need to look at the farming systems (incl. crop diversification to buffer farmers against market, policy and environmental risks), but will also need to take on an Integrated Value Chain (IVC) approach. These solutions will need to be adopted at scale, based on real-world incentives and resonating with a diverse landscape of stakeholders. Awareness needs to be raised by the identification of exposure to risk and impacts that may vary significantly across the country and region. Relevant climate smart practices will need to be disseminated using appropriate vehicles to reach scale, e.g. by linking with existing training programs and impact investors to reach producers and their organizations. With the age of the average cocoa farmer being about 50 years, adapting for the future will also require the industry to make smallholder farmer cocoa production accessible for younger farmers with strong climate smart business models. To confront all these challenges we present an inclusive approach that unites stakeholders throughout the value chain and marries existing value chain interventions focused on changing farmer practices and the provision of innovative financial vehicles with climate science. Our approach tests new methods for identifying and scaling site-specific and appropriate CSA practices, assessed against the risks of exposure on a climate change gradient, which are then mainstreamed into voluntary certification schemes and linked to impact investment in producer organizations.

P-2225-12

Exploring socio-economic and bio-physical indicators for trade-offs in Climate Smart Agriculture adoption: a case study from Tanzania and Uganda

C. Mwongera (1); L. Winowiecki (2); K. Shikuku (1); P. Läderach (3)
(1) International Center for Tropical Agriculture, DAPA/Soils, Nairobi, Kenya; (2) International Center for Tropical Agriculture, Soils, Nairobi, Kenya; (3) International Center for Tropical Agriculture (CIAT), Ciat – asia, Hanoi, Vietnam

The contribution of climate smart agriculture (CSA) in the achievement of sustainable development goals under climate change cannot be overemphasized. CSA sustainably increases productivity, enhances resilience, lowers greenhouse gas emissions, and enhances agricultural household and national food security. In employing CSA, a critical gap lies in the understanding and correct representation of trade-offs across temporal and spatial scales to inform decision makers. The challenge is greater in smallholder farming systems in East Africa, implied by their highly diverse and complex bio–physical and socio–economic environments all of which produce multiple livelihood strategies, opportunities and constraints for increased productivity. Unlocking the indicators for trade-offs in these production systems is key in understanding prospective or ex-ante effects of technology changes and the bio–physical, social and economic outcomes under climate change.

We illustrate key bio–physical and socio–economic indicators for trade-offs in CSA adoption, across diverse landscapes drawing on household surveys in four districts in the Acholi sub-region of northern Uganda and four districts across the Southern Agricultural Growth Corridor of Tanzania in 2014. The data revealed key indicators including yield, input use, food security, off-farm employment, asset poverty, on-farm food security and soil health. The indicators varied across and between sites. We illustrate four types of CSA adoption with the indicators to show the trade-offs in CSA adoption between bio-physical and socio-economic (greater farm income) and environmental and social outcomes (increased environmental health, reduction in poverty levels, reduced labour demand) across landscapes and to determine the likelihood that farmers will adopt...
new practices. For instance farmers are less likely to make changes of food sufficiency as they engage more in off-farm employment. In addition ownership of farm assets enhances the uptake of CSA. Some practices such as slash and burn, common in northern Uganda, leads to soil quality with negative impact on adoption of CSA practices. Engaging heavily in off-farm employment can be an indication of low farm income and willingness to change current practice. In other contexts CSA might engage more on the farm instead of off the farm. The likelihood of engaging in off-farm activities. Farmers with better soil health were generally more willing to adopt CSA practices that in areas with high land degradation. Socio-economic attributes such as higher farm income, high education levels, good technical knowledge and high social preference also increase the likelihood of CSA adoption.

This analysis revealed key barriers for each of the communities that need to be overcome in order to implement and out-scale adoption of locally appropriate CSA practices as well as the importance of assessing the spatial and social context. The study highlights that assessing bio-physical and socio-economic trade-offs indicators across diverse environments could help to better target CSA farming systems to foster adaptation to climate change. P-2225-13

Exploring solutions in response to Bioinvasions threatening agroecosystems under climate change scenarios: pest/predator adaptation and biodiversity management of acarofauna as an example

M. Navajas (1) ; MS. Tixier (2)
(1) Institut National de la Recherche Agronomique, Umr Cbgp (inra / ird / cirad) centre de biologie gestion des populations, Montferrier-sur-Lez, France. (2) Montpellier SupAgro, Umr Cbgp (inra / ird / cirad montpellier supagro) - centre de biologie gestion des populations, Montferrier-sur-Lez, France

Under climate change scenarios, increasing ecological and climatic stresses create new conditions posing a major threat to global agriculture. Particular relevant are invasive alien species introduced into agroecosystems where they often grow into destructive pests. The examples of bioinvasions threatening agricultural systems are numerous particularly and the number is expected to increase. Processes of range expansion and adaptation of pests but also natural enemies are fundamental for understanding the impact these organisms have or will have on ecosystems and agroecosystems under new climatic conditions. These issues are here addressed taken as an example the acarofauna in crop solanaceous systems in the Mediterranean region. A focus is done on an invasive spider mite, Tetranychus urticae. While considering to be native to South America this tropical species has emerged as a new damaging pest in more temperate areas. The future suitability mapping for various agricultural zones for production of beans and maize at the lowlands and down the slope of the mountainous areas.

At least ten stations indicated a temperature rise of 0.3 per decade. High seasonal rainfall variability was experienced during March-May and October-December seasons. The values of Mann–Kendal were in the range of 0.8 – 2.0. The projection showed that temperature will continue to rise by about 0.5 per decade.

There was marginal suitability for production of beans and maize over most parts of the four countries. Most of the western and central part of Kenya showed high potential for production of the two crops. This trend was also reported in central part of Uganda and coastal area of Tanzania.

The future suitability mapping for crops production showed quite similar patterns as the current situation. The highland and rift valley regions would no longer be suitable for growing the crops. The increased human activities around these regions like deforestation probably could account for the decline in suitability of growing these crops.

The threats from climate change are likely to impact negatively on the agricultural activities around the mountainous areas. The farming community living around the slopes of the mountainous areas should diversify the farming activities and best practices to cope with current climate variability and adapt to future climate changes. P-2225-14

The Dynamics of East African Climate and the Suitability of crop Mapping over the Mountainous Areas in a changing climate

G. Otieno (1)
(1) university of nairobi, meteorology, nairobi, Kenya

The East African region is bordered by mountains that are crucial in modulating the climate of the region. The current evidence of climate change and climate variability poses risks to the sustainable development of the society.

The study examined trends in projected rainfall and air temperature and suitability of growing major staple food under a changing climate around the mountainous areas of Kenya, Uganda, Tanzania and Ethiopia. The data were observed rainfall, temperature datasets, the second version of African Rainfall Climatology (ARC2) for the period 1981–2010 and future projection from 2011–2040. The downscaled model estimates of future climate scenarios under Representative Concentration Pathway (RCP 4.5) from Coupled Model Inter-comparison Project Phase 5 (CMIP5). The Mann–Kendal test was used for trend analysis and the FAO–eCO-crop model was used for suitability mapping of various agricultural zones for production of maize and beans at the lowlands and down the slope of the mountainous areas.

Drip irrigation studies were conducted in aerobic rice during Dry Season (DS), 2011 Summer Season (SS) 2012 and Summer Season (SS) 2013 in Coimbatore, Tamil Nadu, India. Drip irrigation treatments comprised of three levels of lateral distance registered as the optimum spacing (the resource concentration hypothesis) and to enhance natural enemy diversity and abundance (under the natural enemy hypothesis). To exploit natural biodiversity but also predict pest management under new climatic conditions, appear as highly informative to advance adapted strategies for climate-smart agriculture. P-2225-15

Climate smart rice practice under drip irrigation

T. Parthasarathi (1) ; V. Koothan (2) ; S. Mohandass (3) ; V. Ell (4)
(1) Tamil Nadu Agricultural University, Crop Physiology, Coimbatore, India; (2) Tamil Nadu Agricultural University, Tamil nadu rice research institute, Aduthurai, India; (3) Tamil Nadu Agricultural University, Department of crop physiology, Coimbatore, India; (4) Neelam Irrigation Ltd, Agronomy chief, Israel, Israel

Drip irrigation studies were conducted in aerobic rice during Dry Season (DS), 2011 Summer Season (SS) 2012 and Summer Season (SS) 2013 in Coimbatore, Tamil Nadu, India. Drip irrigation treatments comprised of three levels of lateral distance namely 0.6, 0.8 and 1.0 m lateral distance registered as the optimum spacing for the better performance in root characters, growth and yield attributes than rest of the lateral distances. From the surface-drip and sub-surface drip irrigation (SDI) treatments, the SDI performed better in terms of root character, growth and yield attributes. Interactively,
latterals spaced at 0.8 m with 1.0 L h⁻¹ drippers laid sub-surface-drip through fertigation exhibit better performance in terms of root parameters (such as root length, Root Mass Density, root biomass and root volume) along with growth attributes (Leaf Area Index, Specific Leaf Weight, Crop Growth Rate and Net Assimilation Rate), yield and its components (such as productive tillers, spikelet numbers, filled grain percentage and Harvest Index) along with water saving when compared with the conventional irrigation treatment. Drip irrigated plants emit lesser methane over the others. Therefore, it is suggested that the lateral spacing of 0.8 m with 1.0 L h⁻¹ drippers under SDI through fertigation is adjudged as a climate smart practice for enhancing the values for water productivity, grain yield and reducing methane emission in areas of limited water availability.

P-2225-16
Private Sector Actions to Enable Climate-Smart Agriculture in Small-Scale Farming in East Africa
S. Quail (1); L. Onyango, (2); J. Kinyangi (3); J. Recha (4)
(1) University of Florida, School of forest resources and conservation, Gainesville, United States of America; (2) Maseno University, Urban and regional planning, Maseno, Kenya; (3) ILRI, Ccafs east africa, Nairobi, Kenya; (4) International Livestock Research Institute, Climate Change, Agriculture and Food Security, Nairobi, Kenya

Climate change is projected to disrupt food production in East Africa. For small-scale farmers, the adoption of agricultural innovations is linked to improved food production and food security, which in turn, will help farmers adopt to altered weather patterns. Agricultural innovations, such as crop varieties, crop rotation, improved farming practices that increase crop productivity and improve the natural resource base that crops are grown on that improve the resilience of agricultural systems. Access to equipment, farm tools, tree seedlings, seeds, agrochemical inputs, etc. – all which are channelled through private sector entities – are needed for the realization of those innovations. Moreover, dissemination of climate information and improved farming practices needed for climate smart agriculture (CSA) and its components (such as productive tillers, spikelet numbers, filled grain percentage and Harvest Index) along with water saving when compared with the conventional irrigation treatment. Drip irrigated plants emit lesser methane over the others. Therefore, it is suggested that the lateral spacing of 0.8 m with 1.0 L h⁻¹ drippers under SDI through fertigation is adjudged as a climate smart practice for enhancing the values for water productivity, grain yield and reducing methane emission in areas of limited water availability.

The private sector plays the most important role in financing agricultural investments, innovation and information dissemination where constraints on government investment render private sector actions all the more important. In East Africa, little is known about the participation of small businesses, independent traders, farmer organizations, large-scale wholesalers, marketing boards and cooperatives. Understanding the mechanisms of climate-smart agriculture (CSA) and its diffusion to small-scale farmers is more critical than ever. In particular, small companies and the informal sector are out of view. Yet such information is critical in exploring how best to engage the private sector in climate-smart agriculture, which typically fall under the purview of government extension, may be more effectively diffused through the private sector.

P-2225-17
Promoting Climate Smart Agriculture along the Coastal Belt of Bangladesh Using ICT
MA. Rahaman (1); MA. Aslam, (2)
(1) ADAMS, Climate Change, Khulna, France; (2) ADAMS, Executive board, Khulna, Bangladesh

Bangladesh is a small country and the highest densely populated country in the world which is vulnerable to different types of environmental disasters. The major disasters and environmental vulnerabilities are floods, water stagnancy, droughts, cyclone, tidal surge, river erosion, salinity, extreme temperature and low light intensity, pests and diseases etc. The vulnerabilities due to climate change are likely to exacerbate in the future. These catastrophic events significantly hinder the agriculture production systems, economic and social development of the country firstly, through damaging the crops, livestock, fisheries and agro-forestry, natural resources, establishments and infrastructures and secondly, pulling back the on-going developments, business and trade at local, regional and even global level. Costal areas are mostly inhabited by the poor and disadvantaged groups. Usually coastal belt is flooded from May/June to November/December. Salinity also restricts agriculture in the coastal areas. In the Coastal Zone, crops are cost due to water Net Assimarcy and flood water or tidal surge during July/August–November/December (5–6 months) in wet seasons. On the other hand, during winter salinity is major threat to agriculture in this area. During summers season, due to high temperature, farmers can not produce crops in their lands. The aim of the action research is to ensure food security of ultra poor climate vulnerable farmers promoting climate-smart agricultural systems in climate vulnerable areas of Bangladesh. The study was conducted in flood and saline prone Bagerhat District of South-West Coastal region of Bangladesh adopting establishment of Climate-smart Agricultural Information Centre; generating local agro-meteorological, soil and hydrological information; developing and regular updating customized software on generated information; disseminating seasonal agro-meteorological, soil and climatic information; using mobile internet to crop suitability using cellular phone, community radio message and mobile internet; educating farmers on ICT and climate resilient agricultural system, soil health, flood & saline tolerant varieties. Based on the empirical findings, the study reveals that ICTs are powerful tools in climate-smart agricultural development. Radio, cellular phone and mobile internet are strong platform in interaction between farmers and climate change experts. ICTs are a remunerative tool for identifying which private sector actors can be strategically targeted for strengthening efforts to scale up climate-smart agriculture and where weaknesses in input and output supply chains exist.

P-2225-18
Floating Vegetables Gardening: Climate Smart Agriculture Technology for Food Security in Tidal Flooded Area of Southern Bangladesh
MA. Rahman (1)
(1) Bangladesh Agricultural Research Institute (BARI), Division of Agronomy, Barisal, Bangladesh

Bangladesh is ranked as one of the most climate-vulnerable countries in the world, where agriculture is the most climate sensitive sector. The consequences of

ABSTRACT BOOK
International Scientific Conference 7-10 July 2015, Paris, France
climate change concerned here are: floods, intrusion of soil and water salinity, sea level rise and tropical cyclones, which are major constraints for sustainable agricultural production in Bangladesh. The coastal area covers about 23 percent of the country and lies on the ‘front line’ of climate change and sea level rise. Most of Bangladesh is less than ten metres above sea level, with almost ten per cent of the country below one metre, making it extremely vulnerable to increasing high tides. Intergovernmental Panel on Climate Change predicted that about 17% of the country’s landmass could be inundated with one metre rise in sea levels in Bangladesh (IPCC’s AR5, 2014). Therefore, climate change adaptation measures must be taken for improving the food security of the people. The coastal area adjacent to sea–bank in southern region of Bangladesh remain under submerge condition for a long period (generally from June to December) during monsoon season or even all the year round due to tidal flooding and erratic rainfall. As a result, there is no scope of crop cultivation on this land naturally that hampers the crop production as well as food security severely particularly for the vulnerable poor people. To cope with the situation, the farmers of tidal flooded area have been practicing a climate smart technology of soilless vegetables gardening since two centuries, which is locally known as “Vasoman or dhap chash,” meaning “Floating Agriculture” (similar to hydroponics). In considering its innovativeness, a study was conducted using questionnaire tool among the randomly selected farmers (n = 150) in three southern districts (Gopalganj, Pirojpur and Barisal) of Bangladesh. During 2012–14 to assess the agro-economic performance of floating vegetables gardening and its potential for adaptation to climate change in the country. The floating beds are built up with many but useful local materials and the single most important component is water hyacinth (Eichhornia crassipes), but topapana (Pista stratiotes), dulali lata (Potamogoton alpinus), son ghash (Imperata cylindrica), vegetable ghash (Hamerthria protensa), aquatic algae (Nitella sp.), wood ash, and dissected coconut fibres are also used for floating bed preparation. A large number of people are involved with this business for supplying the local materials to the farmers. Size of the floating bed varies over district ranges from 15–45 meter long, 1.2–1.5 meter breadth, and 1.0–1.2 meter height. The floating beds are up with rising of tidal flood water level without any damage. Farmers of Gopalganj district usually grow different vegetable crops (okra, Indian spinach, bottle gourd, bitter gourd, tomato, ridge gourd, yard long bean, water melon, musk melon, chilli, etc.) on floating bed during monsoon season without using any fertilizers and pesticides. However, seedlings of above stated vegetable crops are produced on the floating bed in Pirojpur and Barisal districts. Seedlings of vegetables are grown for 3 to 5 times/bed/monsoon season (June–October), where 1000–1200 seedlings/bed are grown in a time. Before growing of vegetables, the floating bed is used for backward tasks (media ball preparation, seed sprouting and set-up, primary nursing etc.) are done mostly by women at homestead nursery. After vegetables cultivation, the decomposed floating beds can be used as compost for succeeding crop production that saves the use of chemical fertilizers as well as environment. The seedlings are sold at local market of nearby districts for income generation (average net return USD 20/bed). Floating gardening provides fresh vegetables for household consumption of the local people and the surplus amount of the product are sold at the local market to earn some cash particularly for the women. Thus, the technology has the potential to provide a means of income and food security for the millions of small households who have no access to land but live close to large bodies of water in southern region. The local innovative technology (floating gardening) may be recognized as agricultural heritage as well as suitable adaptation option in considering its environmental and social aspects in Bangladesh. Therefore, the floating vegetables gardening have been considered as a climate smart agriculture technology for food security in southern region of Bangladesh.
Climate change is anticipated to pose serious threats to public health this century. Infectious diseases present an especially relevant health consideration, as they currently cause over one billion human cases and millions of deaths annually. In particular, in many cases emerging infectious disease (EID) outbreaks in humans, which may or may not involve vectors, in a given region, are a mirror to climate variability. On a micro level, temperature and precipitation–dependent pathogen development cycles may affect the basic reproductive rates determining pathogen survival and spread in a population, and may similarly affect suitable habitat range of its competent host(s). On a macro level, however, EIDs are dependent on a wide range of factors, and thus climate cannot be viewed in isolation when assessing risks. Rapid changes to ecosystems and resulting alteration in composition and abundance of species, as well as anthropogenic practices that are facilitating increased and novel human–animal contact, pose complex biotic dynamics that interface with abiotic climate variability. Given that changes in land use (e.g. deforestation), agricultural production, and global trade and travel are among the leading causes of disease emergence, and overlap with the underlying drivers of biodiversity loss as well as the major direct contributors to greenhouse gas emissions, integrated solutions can be tailored to fit the challenges of all three. From the work of the Future Earth ecoHEALTH project and its partners, we highlight findings from ecological niche modeling for disease such as Nipah virus and malaria to examine the implications of EID risks over the current century, and propose near and long-term solutions that can mitigate known risks and better anticipate future risks where research gaps remain. Given the high economic impact of EIDs, our analysis also prioritizes areas of collaboration with other sectors, including on strategies for land use and agricultural production, to minimize future burden of EIDs while simultaneously promoting a sustainable future.

How climate is intertwined with Dengue Fever Outbreaks in French Guiana

C. Flamand (1) ; P. Roucou (1) ; D. Rousseau (2) ; V. Aidillon (3) ; M. Fabregue (4) ; P. Palany (5) ; J.C. Desenclos (6) ; P. Quenel (7) ; R. Girod (8) ; S. Bréont (9) ; P. Roucou (10)
(1) Institut Pasteur de la Guyane, Unité d’épidémiologie, Cayenne, French Guiana; (2) Institut Pasteur de la Guyane, Laboratoire de virologie, Cayenne, French Guiana; (3) Institut de Veille sanitaire, Cire antilles-guyane, Cayenne, French Guiana; (4) LIRM-CNRS, Umr S506, Montpellier, France; (5) Médecins du monde; (6) Institut Pasteur de l’Outre-mer, Fort-de-France, Martinique; (7) Institut de Veille Sanitaire, Direction générale, Saint-Maurice, France; (8) École des Hautes Études en Santé Publique, Leres-umr 1085 Iser, Rennes, France; (9) Institut Pasteur de la Guyane, Unité d’entomologie Médicale, Cayenne, French Guiana; (10) Centre de Recherches de Climatologie, Université de Bourgogne, Dijon, France

Introduction

Dengue fever (DF) is a serious and potentially life-threatening infection acquired through the bite of infected Aedes aegypti mosquitoes and responsible for major outbreaks in French Guiana. DF transmission is driven by complex interactions between hosts, vectors and viruses that are influenced by environmental, anthropogenic and climatic factors which results in annual seasonality and multiannual variability. Although the onsets of outbreaks seem to be associated with the start of the rainy season, the mechanisms involved in the occurrence of epidemics are not well understood. With the objectives of explaining and predicting DF outbreaks occurrence in French Guiana, we used climatic factors on DF epidemics at different spatial and temporal scales in French Guiana.

Methods

For this analysis that covers the 1991–2013 period, we used biologically confirmed DF epidemiological data, climatological parameters including Niño and NAO indices, atmospheric reanalysis gridded data and meteorological stations data including rainfall, temperatures, relative humidity, sunstroke average and wind force.

We studied the association between incidence of DF and climatic variables to identify temporal predictors of DF outbreaks. Year-to-year disease variability was investigated by linking atmospheric and oceanic synoptic patterns to the epidemiological regional context. Finally, contextual sequential patterns extraction techniques were used at local scale and weekly time step to identify the most significant climatic factors influencing DF incidence dynamics.

Results

From 1991 to 2013, more than 23,600 biologically confirmed DF cases were recorded in French Guiana and 8 major outbreaks were identified. Annual activity was characterized by a seasonal increase of incidence levels during the first quarter of the year. We found that outbreak occurrence can be linked with summer Niño conditions, 6 months before the onset of the outbreak. Furthermore, a statistical model based only on climate indicators indicated that 50% of the disease variance from year-to-year is explained by the dry season rainfall, forecasting epidemic years with a hit rate of 75% and a positive predictive value of 75%.

At regional scale, the outbreak onset in specific areas was frequently associated with a 4–6 week lag with an increase in the relative humidity, high levels of rainfall and a decrease of temperature. During epidemic period, local specific weather conditions were not predictive of the epidemic peak, where a predominance of the cumulative incidence occurred.

Conclusion

Using complementary approaches at different geographic scales we used meteorological and climate data to understand and predict DF outbreaks in French Guiana. Our findings will be useful to timely target appropriate public health interventions to mitigate the effects of major outbreak risks, particularly in areas where resources are limited and the medical services may become overwhelmed by large epidemics.

This first successful step opens new opportunities in the DF risk prediction. Future work will be a more in–depth focus on influence of future climate conditions according to different scenarios of climate change on epidemiologic patterns.

The PALUCLIM project. Impacts of climatic factors on the production of malaria vectors in the rural Sahel: Application to the Nouna region (Burkina-Faso)

C. Vignolles (1) ; C. Viel (2) ; V. Machault (3) ; R. Sauerborn (4) ; P. Dambach (4) ; A. Sié (5) ; C. Rogier (6) ; Y. Tourre (7)
(1) CNES, Toulouse, France; (2) Météo–France, Toulouse, France; (3) Laboratoire d’Aérologie, Toulouse, France; (4) Helmholtz University, Munich, Germany; (5) Centre de Recherche en Santé de Nouna, Nouna, Burkina Faso; (6) Institut Pasteur de Madagascar, Antananarivo, Madagascar; (7) Columbia University, Climate Physics /LDEO, Palisades, United States of America

Emerging/re-emerging infectious diseases with high epidemiological potential risks, lead public health managers to adapt their policies. Adaptation includes early knowledge of risks. The latter requires new tools to prevent re-emerging risks. Infectious diseases such as Rift valley fever or malaria are closely tied to climatic and/or natural and anthropogenic environmental factors among which some could be identified using remote-sensing climate indicators. The risk is assimilated into bio–mathematical models thus allowing re-emerging risks’ assessment. The French Spatial Agency (CNES) with its partners has developed a conceptual approach so-called PALUCLIM based upon studying climate–environment–health relationships with applicable products.

This multidisciplinary approach is based upon the study of the key mechanisms favoring the surge and spread of those diseases. Analysis of those processes is a key step in the development of new and original risk mapping using Earth observation satellite data. The primary mission is to show how those adapted space products could contribute to diseases surveillance policy and improve Early Warning Systems (EWS). The overall objective is to attempt predicting and mitigating public health impacts from epidemics.
This approach has been applied with success for malaria in Burkina Faso through the Palclim project. This project was to apply the Tele-epidemiology conceptual approach linking climate, environment and vector-borne diseases such as malaria in the Sahel region of Nouna (Burkina Faso) with the aim of assessing the impacts of climate variability on malaria entomological risk, a first step for risks of malaria outbreaks and then to analyze impacts from risks' forecasting.

The project objectives were to provide and validate dynamic entomological risk maps, then to study adaptation processes for controlling management, i.e., addressing mosquito-risk, and the project objectives were to provide and validate dynamic entomological risk maps, then to study adaptation processes for controlling management, i.e., addressing mosquito-risk, and to study the impacts of climate variability from seasonal to low frequency climatic signals, including tendencies and climate change—on risks' forecasting.

To achieve these objectives, the Palclim project integrated efforts from several teams and partners: CNES, Méteo-France, Public Health Institute of the University Hospital of Heidelberg (Germany), Centre de Recherche en Santé de Nouna (Burkina Faso) representing the Health Ministry. As such it benefited from previous expertise and results obtained by the different partners in entomology, climate, environmental sciences, and in Tele-epidemiology. In this work it was shown that:

- based upon satellite (SPOT 5) and in-situ data it was possible to build an operational model to predict location of larvae sites and distribute dynamic maps on larval productivity for local villages;
- based upon the larval productivity maps for targeted larvicide strategy could be implemented.

The added-values from the use of entomological risk maps were obvious in terms of additional element such as economical savings for decision makers. The use of larval productivity maps for larvicide treatment was perceived locally as extremely positive.

As of today, rainfall is the main meteorological driving parameter for the knowledge of vectors' density (which is used for the evaluation of entomological risk maps). The malaria entomological risk as a function of the weather/climate spatio-temporal variability was undertaken. An impact model was developed based upon an existing model (Graig’s model), particularly efficient when resources are limited. The climate analyses were done for different temporal scales (i.e., seasonal, quasi-biennial, inter-annual, low-frequencies and climate change). The model could thus be used immediately on an operational mode. It was found that the new main driving factor for the upcoming years will be the temperature increase leading to decreased malaria risks (at least next 50 years), knowing that models have a hard time to predict rainfall variability in the near future.

**O-2226-04**

Will climate warming decrease winter mortality in Europe?

J. Ballester(1) ; J.M. Robine (2) ; FR. Herrmann (3) ; X. Rodó (1)

(1) Institut Català de Ciències del Clima, Barcelona, Spain; (2) INSERM, Démographie et santé, Montpellier, France; (3) Department of Rehabilitation and Geriatrics, Geneva medical school and university hospitals, Geneva, Switzerland

The steady increase in greenhouse gas concentrations is inducing a detectable rise in global temperatures. The sensitivity of a degree of adaptation of human societies to warming temperatures is however a transcendental question not comprehensively addressed to date. Recent studies have pointed to improvements in housing, standard of living and healthcare systems as primary factors explaining the progressively decreasing year-to-year association between excess winter deaths and winter temperatures in economically developed societies such as Europe and the United States.

Here we show the link between temperature and daily numbers of deaths in nearly 200 regions in western Europe, which is used to characterize the spatial picture of human vulnerability to climate conditions in winter. Our analyses show that only the United Kingdom, the Benelux and northern France have successfully taken steps towards the adaptation to harsh winters, and that the Mediterranean and eastern countries, including Germany, Austria and Switzerland, still remain sensitive to intense cold seasons. Results from this project will provide a tool to help energy planners, health professionals, and policy makers to adapt in the least cost-effective way to the upcoming climate changes.

**O-2226-05**

Achieving Health Dividends from Climate Change Mitigation Policies

A. Haines (1) ; J. Milner (1) ; R. Green (2) ; A. Dangour (2) ; P. Wilkinson (1)

(1) London School of Hygiene and Tropical Medicine, Social and Environmental Sciences, and in tele-epidemiology. In this work it was shown that:

- based upon satellite (SPOT 5) and in-situ data it was possible to build an operational model to predict location of larvae sites and distribute dynamic maps on larval productivity for local villages;
- based upon the larval productivity maps for targeted larvicide strategy could be implemented.

The added-values from the use of entomological risk maps were obvious in terms of additional element such as economical savings for decision makers. The use of larval productivity maps for larvicide treatment was perceived locally as extremely positive.

As of today, rainfall is the main meteorological driving parameter for the knowledge of vectors' density (which is used for the evaluation of entomological risk maps). The malaria entomological risk as a function of the weather/climate spatio-temporal variability was undertaken. An impact model was developed based upon an existing model (Graig’s model), particularly efficient when resources are limited. The climate analyses were done for different temporal scales (i.e., seasonal, quasi-biennial, inter-annual, low-frequencies and climate change). The model could thus be used immediately on an operational mode. It was found that the new main driving factor for the upcoming years will be the temperature increase leading to decreased malaria risks (at least next 50 years), knowing that models have a hard time to predict rainfall variability in the near future.

**P-2226-01**

Urbanization, Climate Change & Human Health: A Study on Four Megacities of Urban India

J. Basu (1)

(1) West Bengal State University, Economics, Kolkata, West Bengal, India

There is growing interest in the range of co-benefits from well designed policies to reduce greenhouse gas (GHG) emissions. Importantly, avoided climate impacts may accrue sooner than the benefits projected from reducing the magnitude of climate change and are subject to less uncertainty because the pathways linking the policy measure, changes in exposures and subsequent health outcomes are well established from epidemiological studies. A range of studies published over recent years have suggested significant net health benefits across several mitigation strategies in both high and low income countries. Studies estimating the ancillary health effects of mitigation strategies (while acknowledging that co-harms also may result) use a range of modelling approaches, and draw expertise from public health, agriculture, environmental sciences, nutrition, urban planning, architecture and other disciplines to generate policy-relevant outputs. Reductions in fine particulate air pollution, with major benefits to health, result from policies to reduce fossil fuel use – particularly reduced coal and diesel combustion. In the transport sector, policies which increase active travel (walking and cycling) would also reduce CO2 emissions and lead to substantial benefits, including for cardiovascular health, which would greatly outweigh increased risk of road traffic injuries. Interventions which increase energy efficiency in the housing sector have the potential to lead to considerable health benefits through improved internal temperatures during winter and protection against outdoor air pollution, as long as compensatory ventilation is provided to reduce exposure to indoor-generated pollutants. Relatively modest changes to dietary patterns can lead to substantial benefits for health and also reduce GHG emissions. However, drastic GHG reductions may require unpalatable modification of current diets. This presentation will give an overview of recent studies that have estimated the magnitude of health co-benefits from strategies to reduce carbon dioxide and short lived climate pollutants in the energy, transport, housing and food and agriculture sectors in high and low income settings. It will also discuss key methodological issues in designing studies. It will outline how valuation of health and other co-benefits can help offset the costs of mitigation policies and potentially make them more attractive to decision makers. Finally it will also consider potential co-harms of poorly designed policies and how such risks can be managed.
The World Bank in 2002 reported that in poor countries as much as 80 per cent of future economic growth occurred in cities and 60 percent of the world’s population will be residing in cities by 2050. The increase in the average temperatures in the megacities in India is accompanied by the increase in population. The Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) has predicted that by 2020 the global temperature would increase by 1.8 °C–4 °C and which has effect on increased heat-related mortality and morbidity and greater frequency of infectious diseases like diarrhea, cholera and other bacterial diseases. The paper attempts to address the impact of precipitation in relation to human mortality pattern in India and the distribution of disease vectors like malaria, dengue and diarrhoea diseases at the four megacities like Mumbai, Delhi, Kolkata and Chennai of India. In addition, the paper also attempts to establish the impact of urbanization on climatic variables like temperature and rainfall. The objectives of the paper are four fold. First, is to examine trends in summer temperature, monsoon temperature, post monsoon temperature and winter temperature at four megacities like Mumbai, Delhi, Kolkata and Chennai of India. Second, is to examine the impact of precipitation on the disease vector like malaria in India. Third, is to examine how climate change affects the distribution of disease vectors in the four megacities of India. Fourth, is to establish the relationship between urbanization and temperature change at four mega cities of India.

The paper utilizes time series data on temperature and precipitation, number of malaria deaths from the various reports of Indian Metrological Department for period 1978 – 2008. The analysis of trends in temperature at four largest cities is performed on data for the period 1901 – 1991. Regression analysis is done to estimate the effects of precipitation on malaria cases. As the data set comprises time series in nature, before doing regression analysis we have applied unit root test and the Augmented Dickey Fuller test (ADF test) is employed for this purpose. After conforming the data are stationary we have applied regression analysis to show the impact of precipitation on malaria death.

In the univariate case, it is possible to view the stationarity of \( Y_t \) as being dependent on the magnitude \( (a_1 - 1) \), that is,

\[
Y_t = a_1 Y_{t-1} + \epsilon_t
\]

\[
\Delta Y_t = \gamma Y_{t-1} + \epsilon_t\quad \text{Where} \quad \gamma = a_1 - 1
\]

In the presence of trend of drift the Dickey and Fuller equation can be written as

\[
\Delta Y_t = a_0 + \gamma Y_{t-1} + a_2 t + \epsilon_t
\]

where \( a_0 \) and \( a_2 \) represent the drift and trend component respectively.

The result of the unit root test shows that death due to malaria (MDt) and precipitation (Rt) are stationary at the first difference. After checking stationary test we have regressed death due to malaria on precipitation.

The regression equation is given below

\[
\text{Log}K_t = b \text{Log} Z_t
\]

Where \( K_t = \text{Log MDt} - \text{Log MDt-1} \)

\( Z_t = \text{Log Rt} - \text{Log Rt-1} \)

The result shows that there is a positive and significant relation between precipitation and death rate due to malaria. The higher is the precipitation and higher is the death rate due to malaria. Most of the trends showed positive change in temperature with different rates in different seasons. In some cases, the trends showed asymmetry. The results of the impact of urbanization on temperature revealed that there is a positive relation between the increase in temperature change and the increase in population change on the annual scale. But on seasonal scale this is applicable for monsoon, post-monsoon and winter temperature and not for summer season. The paper has important policy implication for improving water quality.

**Scalining heat-mortality relationships recorded in cities to the global scale**

L. Costa, (1) ; L. Krummenauer, (1) ; A. Holsten, (1) ; J. Kropp, (1) ; (1) PIK, Potsdam, Germany

A large number of epidemiologic studies relating air temperature and mortality in cities have been conducted but they findings not generalized to continental scales. The studies usually attempt to establish the existence of a threshold–mortality temperature (TMTs), that is, a temperature value beyond which mortality in a city deviates from the normal expected.

In this work we have compiled and homogenized threshold–mortality temperatures (TMTs) found in peer-reviewed literature for circa 90 cities worldwide. The chosen unit for homogenization was mean apparent temperature, since it is a composite measure of temperature and humidity. A multivariate linear regression between TMT’s and a set of 12 independent variables was performed. The set included several measures of the climatologic features of a city, as well as physical urban features city density, size and fraction of urban spaces. The linear regression exercise returned 30-year mean amplitude and 30–year average temperature as the best explanatory variables (adjusted \( R^2 = 0.66 \)). Results point therefore for a significant role of climate alone in shaping the ability of urban population in sustaining heat–stress, while the remaining variability is likely attributed to factors such as demographics or health care standards.

In order to reflect the existence of a physiologic limit for temperature, a sigmoid function (S–shape curve) was fitted to the TMT’s using the same set of independent variables as for the case of the linear regression. 30–year mean of the hottest month returned the fit with the lowest residual standard error. The saturation value for the sigmoid function, that is, an approximation of the physiologic limit (or adaptability limit), was set and 45 degrees, in relation to the upper limit of temperature recorded at permanently habitable regions in the world and further evidences from literature. The robustness of the sigmoid function was tested for subsets of TMT’s from different climatic zones. The fit preformed best at sub–tropical–tropical–wet climates, and worst at humid–continental climates. Climate projections of temperature were superimposed with the results of the sigmoid fit in order to highlight the regions where the largest deviation from air temperature to TMT’s are expected. In particular, the function allows for the exploration of several «adaptability» scenarios by varying the speed with which a region can «move» along the fit function.

There is still a considerable amount of variance in TMTS not captured by our approach but we have successfully captured the role of climate in shaping the adaptive capacity of the urban population. We also moved closer into bridging the persistent gap between research undertaken at the case–study and the need for global generalizations of results. Finally, following the proposed function, first order approximations of TMT’s can be made for regions where temperature–mortality studies are absent.

**Climate change effects on the erythemal and vitamin D weighted UV daily doses in South America and Antartica: Impacts on the health of populations**

M. De Paula Correa (1) ; G. Moraes (1) ; S. Godin Beekmann (2) ; E. Mahé, (3)

(1) Universidade Federal de Itajubá (Federal University of Itajubá), Instituto de recursos naturais (natural resources institute), Itajubá, Brazil; (2) CNRS, IPSL/LATMOS, Guyancourt, France; (3) Centre Hospitalier Victor Dupouy, Departement de dermatologie, Argenteuil, France

Recent studies show that the ozone layer will be recovered until 2050. This is a significant result of the Montreal Protocol which points out the success of this environmental protection agreement. However, climate change projections show that the total ozone content will have a relevant increase until the end of this century, mainly at higher latitudes. On one hand, this increase can reduce the
Evolution of surface UV radiation in relation to ozone depletion and climate change

S. Godin Beeckmann (1); M. De Paula Correa (2); E. Mahé (3)
(1) CNRS, IPS/LATMOS, Guyancourt, France; (2) Universidade Federal de Itajubá (Federal University of Itajubá), Instituto de recursos e desenvolvimento sustentável (sustainable development institute), Itajubá, Brazil; (3) Centre Hospitalier Victor Dupouy, Département de dermatologie, Argenteuil, France

Exposure to ultraviolet (UV) radiation is known to be a risk factor for several diseases such as skin cancers and cataracts. On the other hand, a number of studies have described the benefits of UV exposure in relation to the synthesis of vitamin D and prevention of several diseases. The evolution of surface UV radiation has been under scrutinity in the last decades due to the discovery of ozone depletion in the middle atmosphere. Atmospheric ozone is the main atmospheric absorber of UV-B radiation (280–320 nm spectral range) and its depletion has raised concerns about the protection of human populations, living organisms and ecosystems against dangerous UV radiation. The rapid understanding in the 1980s of the main processes involved in stratospheric ozone destruction, which incriminated halogen substances emitted by human activities, led to the regulation of the emission of these ozone-depleting substances (ODS). Since then, ODS abundances have continued to increase up to the mid or end of the nineties, depending on latitude, and have now started to decrease slowly. As a consequence, the ozone layer has started to recover and cardiovascular and respiratory systems show that the decrease of ODS content is expected to be the dominant cause of the future long-term evolution of stratospheric ozone, climate change effects and natural variability of the atmosphere. Inhibiting the ambiguous detection of the recovery expected from ODS decrease.

Chemistry–Climate models indicate that minimum levels of stratospheric ozone have been reached in the early 21st century. The recovery of the ozone layer is forecasted in a period ranging between 2015 and 2030 in the northern hemisphere, with a disappearance of the Antarctic ozone hole after 2050. Due to climate change induced effects on transport processes and temperature climatology in the middle atmosphere, models simulate a super-recovery of ozone in the polar and mid-latitude regions and an under recovery in the tropics. The future evolution of ozone will thus have an impact on surface UV at global scale and on the health related UV doses.

This presentation will review the latest results on the past and future long-term evolution of global ozone and surface UV (total solar dose) in clear-sky erythemal and vitamin D effective UV doses for Europe over the period 2006 to 2100, based on CMIPs simulation of total ozone and aerosols will also be presented.

Seasonal Variations in Emergency Department Visits of Schizophrenic Patients in Sofia, Bulgaria

Z. Spasova (1)
(1) National Center of Public Health and Analyses, Health Policies Analyses, Sofia, Bulgaria

Climate change is making hot summer days hotter and stretching their numbers into heat waves. And the heat is causing more than just discomfort – as temperatures rise, so are the number of illnesses, emergency room visits, and deaths. Among the risk groups are young children and elderly people, people with chronically diseases especially people with mental disorders living in big cities where the effect of “heat island” makes the heat waves more severe.

It’s little studied the effect of hot weather and the effect of the season on people with mental disorders and specifically schizophrenia (as one of the mostly common and severe mental disorders). Schizophrenia is characterized by enormous societal and economic costs due to the extensive therapeutic care and loss of economic productivity, as well as personal suffering and stigma which often affect the patient and his/her family for most of the patient’s life. As for schizophrenia patients, there is still no cure, the research of etiologic factors, particularly environmental ones that could be avoided and used in effective prevention programs, is essential.

Many studies have demonstrated evidences of seasonal patterns in the incidence of psychiatric disorders, and schizophrenia in particular. It is known since the time of Esquirol (1838) that the number of patients admitted in mental hospitals increases in summer months and decreases in winter. Most of the studies on seasonal distribution of hospital admissions in schizophrenia also report summer peaks, some of these for female patients only. With respect to the factors responsible for the summer excess of admissions, Myers and the team suggested a rise in ambient temperature; Parker and Walter, the increasing luminance; and Carney et al., the length of day. Social factors, such as summer holidays, “are unlikely to have an effect” (Takei et al.).

While the problem of seasonal admissions of patients with schizophrenia has been widely discussed in Western Europe, America and Australia, in Eastern Europe it...
has been neglected. We are not aware of any published research on this subject in Bulgaria, which makes the present study important as a contribution to the scientific literature on the problem in the country and in the South East Europe region. Its findings could also raise the awareness of the problem of health care management for psychiatric patients in SEE countries besides Bulgaria.

The purpose of this study was to reveal the seasonal distribution of emergency department visits of schizophrenic patients in Sofia, Bulgaria.

We collected daily data for visits of patients with schizophrenia, schizotypal and delusional disorders in the emergency center of the regional dispenser for mental disorders in the city of Sofia for the period 1998–2003. The total number of emergency visits was 5723 (mean daily visits: $5.04 \pm 2.4$). T-test was used to compare the monthly and seasonal distribution of visits.

The season with the highest levels of emergency visits was summer, and the lowest levels were observed in winter ($p<0.0001$). Spring and autumn had intermediate values close to the mean value, and significantly differentiated from winter values. The month with the highest admission rates was September, followed by May and the three summer’s months. The lowest levels were observed in December, October and January, with statistically significant differences observed between the values of all the three months. Differences between July values compared with December and October values were significant, but not with January values.

The study showed significant seasonal and monthly differences in emergency schizophrenia–nics’ visits. The data confirm the outcome of studies conducted in countries with temperate climate in the Northern Hemisphere. The results are particularly relevant against the backdrop of rising ambient temperatures and the tendency of the freeway of growing urban greenhouse gases observed in recent decades in Bulgaria. These results could prove useful for psychiatrists, public health specialists, and governmental authorities dealing with team planning and prevention programs in the field of public health.

---

**2228 - Removing Barriers to Climate Change Mitigation at City Level**

**K-2228-01**

**Title not communicated**

A. Patt

(1) ETH Zurich, Switzerland

Abstract not communicated

---

**K-2228-02**

**Title not communicated**

P. Buergi

(1) South Pole Group, Switzerland

Abstract not communicated

---

**Making Cities Resilient to Climate Change: Identifying ‘win-win’ interventions**

H. Dulal

(1) Abt Associates, International Economic Growth, Bethesda, Maryland, United States of America

Urbanization has truly become a global phenomenon. From a mere 10 percent in 1900, the percentage of global population living in urban areas now exceeds 50 percent. With rapid urbanization, urban emissions have also increased over the decades. Cities currently account for about 75 percent of global energy consumption and 80 percent of global greenhouse gas emissions. The greenhouse gas emission footprints of cities have been increasing over the years, for the cities in developing countries. greenhouse gas (GHG) mitigation is still not a priority. It is a «low-priority» issue. Given the resource constraints and competing local priorities, developing countries’ cities are more interested in dealing with rapidly deteriorating air and water quality than use their scarce resources for urban climate change mitigation.

The existing reluctance, however, can be overcome if cities are made aware of the fact that bundling of policy tools can actually help them overcome their perpetual struggle against increasing urban environmental externalities and contain rising urban greenhouse gas emissions. The proposed paper intends to identify sectors and policy instruments, adoption of which, will not only ensure the reduction of rising urban environmental externalities in developing countries, but also help contain rapidly growing urban greenhouse gas emissions and provide climate change adaptation co-benefits.
ABSTRACT BOOK

Call for innovative and less conventional approaches. Behavioral biases, ancillary costs and benefits of response uncertain dimensions. Non-market values, inequities, which requires moving from pure cost benefit analysis to dwell on the economic valuation of climate change impacts on urban forests landscape and designed innovative strategies that will ensure sustainability and improvement of urban living environment. It was investigated through secondary data, field investigation, enquiries to relevant stakeholders, direct assessment and observations of urban and peri-urban forest landscapes in Cameroon. These analyses highlight the extreme diversity of environmental resources from urban forests in Cameroon. Rapid urban population growth, limited land area, and poor implementation of government policies are some factors affecting urban forests development and are responsible for vicious cycle of environmental degradation in urban areas in Cameroon. The results contribute elements for strategic and operational planning. Urban forestry management is an important strategy to improve urban living and working environments. There is a need to highlight successful strategies and actions concerning the management of urban and peri-urban forests. Involvement of all stakeholders and users in reflections and in the implementation of policies concerning the management of the urban and peri-urban forests should be adopted and advocated, to ensure sustainable development and to ensure that cities, trees and forests grow together to meet the needs of urbanized societies.

2228-Poster Presentations

P-2228-01

Urban and peri-urban forestry in the face of climate change in Cameroon: challenges and new perspectives for sustainability

GH. Chekuimo (1)
(1) Centre for Research in Economics and Sustainable Development, Yaounde, Cameroon, Agriculture and Sustainable Development, Yaounde, Centre, Cameroon

Urban forestry is a relatively new, multidisciplinary approach in international forest research. Rapid urbanization and climate change raise several issues for those who are responsible for developing policies and making decisions at local, national and international levels. Urban trees provide a significant contribution to building resilient cities and improving health and well-being, such as through mitigating natural disasters, providing ecosystem services, reducing energy costs or increasing property values. However, urban and peri-urban forest ecosystems in Cameroon are steadily increasingly under pressure from their city populations. This study assessed the status of urban and peri-urban forestry, evaluated the effect of population growth on urban forests landscape and designed innovative strategies that will ensure sustainability and improvement of urban living environment. It was investigated through secondary data, field investigation, enquiries to relevant stakeholders, direct assessment and observations of urban and peri-urban forest landscapes in Cameroon. These analyses highlight the extreme diversity of environmental resources from urban forests in Cameroon. Rapid urban population growth, limited land area, and poor implementation of government policies are some factors affecting urban forests development and are responsible for vicious cycle of environmental degradation in urban areas in Cameroon. The results contribute elements for strategic and operational planning. Urban forestry management is an important strategy to improve urban living and working environments. There is a need to highlight successful strategies and actions concerning the management of urban and peri-urban forests. Involvement of all stakeholders and users in reflections and in the implementation of policies concerning the management of the urban and peri-urban forests should be adopted and advocated, to ensure sustainable development and to ensure that cities, trees and forests grow together to meet the needs of urbanized societies.

2229-Cities and their environments: Assessing Climate Change Impacts, Adaptation and Mitigation strategies across scales from rural to urban

ORAL PRESENTATIONS

K-2229-01

Sustainable Futures in Rural and Peri-Urban Areas

D. Purnamita (1); J. Morton (2)
(1) Institute of Economic Growth, Environmental and Natural Resource Economics Unit, Delhi, India; (2) University of Greenwich, Greenwich, United Kingdom

This keynote will focus on the possible impacts from climate change on rural areas and rural–urban continuums, with special emphasis on the implications for human settlement. It will consist of contributions for resilience for the future in recognition of a two-way relationship between sustainable economic development and climate change. A wide range of human and ecosystem interactions define the risks from climate change, in many parts of the world, including the developing and the least developed, where multiple stressors co-exist. Illustrations to highlight these aspects will be drawn from material from the ARS report of the IPCC. The opportunities and challenges in bridging the gaps between quantitative and qualitative dimensions, of integration across scales and timelines is also to be discussed given the multiple sources of vulnerability and differences in development across regions of the world. In this context, the presentation will dwell on the economic valuation of climate change impacts which requires moving from pure cost benefit analysis to multi-metric situations with consideration of the risk and uncertainty dimensions. Non–market values, inequities, behavioral biases, ancillary costs and benefits of response options and aggregation of values across multiple contexts call for innovative and less conventional approaches.

K-2229-02

Cooling Our Cities: International efforts to implement heat island countermeasures

H. Akbari (1)
(1) Concordia University, BCEE, Montreal, Canada

As the threat of climate change becomes more pronounced, a number of scientists have proposed supplementing the full range of mitigation efforts with geo-engineering (manipulation of the Earth’s environment) to quickly respond to this threat. Many proposed geo-engineering techniques are novel and unproven. One simple technology has been in practice for thousands of years: changing the solar reflectance (albedo) of the built surface. “Cool roofs” and “cool pavements” should be among the first geo-engineering techniques used to combat global warming.

Increasing the solar reflectance of the urban surface reduce its solar heat gain, lowers its temperatures, and decreases its outflow of thermal infrared radiation into the atmosphere. This process of “negative radiative forcing” can help counter the effects of global warming. We estimate that resurfacing conventional dark roofs with a cool white material that has a long-term solar reflectance of 0.60 or more increases its solar reflectance by at least 0.40. Retrofitting 100 m2 of roof has an effect on radiative forcing equivalent to a one-time offset of 10 tonnes of CO2. Similarly, the solar reflectance of pavement can be raised on average by about 0.15, the equivalent of a 4 t reduction in CO2 per 100 m2.

In addition, cool roofs reduce cooling-energy use in air conditioned buildings and increase comfort in unconditioned buildings; and cool roofs and cool pavements mitigate summer urban heat islands, improving outdoor air quality and comfort. Installing cool roofs and cool pavements in cities worldwide is a compelling win-win activity that can be undertaken immediately outside of international negotiations to cap CO2 emissions. We review the status of cool roof and cool pavements technologies, policies, and programs in the U.S., Europe, and Asia. We propose an international campaign to use solar reflective materials when roofs and pavements are built or resurfaced in temperate and tropical regions.

This presentation will discuss the technologies and international policies related to development and utilization of cool construction materials.

K-2229-03

Towards an integrated model for more sustainable urban (re-)planning

D. Robinson (1)
(1) University of Nottingham, Architecture and built environment, Nottingham, United Kingdom

International Scientific Conference     7-10 July 2015    Paris, France

349

ABSTRACT BOOK
Sustainability has become a byword. Whilst it is understood that we are now mainly an urban species, that the overwhelming majority of economic activity and associated resource use takes place in cities, some surprisingly basic questions remain unanswered: How do we define city sustainability? How do we then measure it and determine how sustainable a city is? Which are the most effective strategies and policy measures to bring about positive change? How do we model them to evaluate their effectiveness? How do we then implement them? These are some of the questions currently being tackled by the Laboratory of Urban Complexity and Sustainability (LUCAS) at Nottingham. Positioned within this landscape, I will focus in this talk on the challenges we face in developing a platform for modelling the principle urban resource flows, in a sufficiently spatially sensitive manner to support the testing of scenarios to minimise these flows (or measure reduction in them) in the future and how cities might transition to these target future states.

Climate Change in Rural Areas: Reflections

J. Morton (1)

(1) Natural Resources Institute, University of Greenwich, Livelihoods and Institutions, Chatham, Maritime, Kent, United Kingdom

The Contribution of Working Group 2 to the IPCC Fifth Assessment Report (2014) included for the first time a Chapter on Rural Areas. This presentation will be a reflection on the writing of that chapter by one of its two Co-ordinating Lead Authors. Some of the questions posed will be as follows:

- Is there something specific about rural areas (or “rurality”) that can make them an object of study in the context of climate change, along the continuum from low-income to high-income countries?
- How can the different experiences of poverty and ill-being in rural and urban contexts, as they exist and as they will be exacerbated by climate change, best be compared in a non-reductionist manner?
- How best can we conceptualise and research interactions between adaptation and mitigation in rural areas?

How best can we conceptualise and research linkages between rural and urban areas and the ways they will be impacted, and will adapt, under climate change?

Efficiency of Waste Management of Different Cities in the Philippines: Assessment and Its Implication to Climate Change Mitigation and Adaptation Policies

J. Pagunsan (1); K. Shimada, (2)

(1) Office of the Ombudsman, Field Investigation Office II, Quezon City, Philippines; (2) Ritsumeikan University, Economics, Kusatsu City, Japan

Rapid increase in the emission of greenhouse gases (GHGs) particularly in the waste management processes resulted in socio-economic changes and various environmental issues in major cities of the world. Increasing trends of GHG emissions are due to the rapid urbanization and a booming economic development in these cities particularly in developing countries like Philippines. Globally, the risks and uncertainties of climate change tend to be more complex and costly which can aggravate the threat to human civilization and economic development of a particular country. This pressing issue at hand calls for planning that can take into account the comprehensive approach to evaluating and solving discipline specific issues in addressing climate change such as understanding long-range consequences of present actions; understanding needs for disadvantaged populations; and the way and means of communicating and sharing knowledge between the built environment and natural environment fall naturally under the toolbox of planners. Methods and tools in planning are robust enough for this challenge (Talen, 1996). New research is taking a critical look at what approaches should and are being conducted across the US (Jepson & Haines, 2014). This is exactly the type of environment that fosters more integration of planning for climate change into the routine high visibility planning tools in planning are robust enough for this challenge (Talen, 1996). New research is taking a critical look at what approaches should and are being conducted across the US (Jepson & Haines, 2014).

Continued Growth, Sustainability and Climate Change in America’s Energy Capital

K. Lester (1)

(1) Rice University, Shell Center for Sustainability, Houston, TX, United States of America

Planners are uniquely situated to contribute a comprehensive approach to evaluating and solving development issues. This presentation will focus in this talk on the challenges we face in developing a platform for modelling the principle urban resource flows, in a sufficiently spatially sensitive manner to support the testing of scenarios to minimise these flows (or measure reduction in them) in the future and how cities might transition to these target future states.

Efficiency of Waste Management of Different Cities in the Philippines: Assessment and Its Implication to Climate Change Mitigation and Adaptation Policies

J. Pagunsan (1); K. Shimada, (2)

(1) Office of the Ombudsman, Field Investigation Office II, Quezon City, Philippines; (2) Ritsumeikan University, Economics, Kusatsu City, Japan

Rapid increase in the emission of greenhouse gases (GHGs) particularly in the waste management processes resulted in socio-economic changes and various environmental issues in major cities of the world. Increasing trends of GHG emissions are due to the rapid urbanization and a booming economic development in these cities particularly in developing countries like Philippines. Globally, the risks and uncertainties of climate change tend to be more complex and costly which can aggravate the threat to human civilization and economic development of a particular country. This pressing issue at hand calls for planning that can take into account the comprehensive approach to evaluating and solving discipline specific issues in addressing climate change such as understanding long-range consequences of present actions; understanding needs for disadvantaged populations; and the way and means of communicating and sharing knowledge between the built environment and natural environment fall naturally under the toolbox of planners. Methods and tools in planning are robust enough for this challenge (Talen, 1996). New research is taking a critical look at what approaches should and are being conducted across the US (Jepson & Haines, 2014). This is exactly the type of environment that fosters more integration of planning for climate change into the routine high visibility planning tools in planning are robust enough for this challenge (Talen, 1996). New research is taking a critical look at what approaches should and are being conducted across the US (Jepson & Haines, 2014).
A comprehensive suite of sustainability indicators from the Houston Sustainability Indicators project (HSI), will serve as the basis to measure to characterize Houston's environment in this study. The HSI project has reported on the sustainable development of the City of Houston for the past four years and produced four (4) reports showing dynamics at various spatial levels (Blackburn, 2011; King, 2014; 2013; 2012). Indicators will be projected to 2030 and 2050 and multivariate analysis will be conducted on the indicators and communities across the city to support identification of major trends and development opportunities at these two times (2030 and 2050). Specifically, this exploratory research will seek to identify factors explaining limits to growth around the stress nexus issues of energy, water, food and land use. Planning for climate change is essential in current times of uncertainty and this research contributes new findings towards this effort (Barth, 2011).


O-2229-05
Climate change and water management issues in megacities, the example of Paris metropolitan area

B. Nguyen (1); JP. Tabuchi (2)
(1) UNESCO, SC/HYD/GSS, Paris, France; (2) SIAAP, Direction santé environnement, Paris, France

Are the effects of the climate change at the dawn of the 21st century already visible at the operational water management scale? Some elements speak in favor of it. The scheme and the infrastructures of the drinking water supply system of the capital of France date back to 153 years; in the case of the rainwater treatment in Paris began at the end of the 19th century. The drawing of the underground water springs, which supply even today half of the 2.3 millions of Parisians, also benefits from long and precise records since 1872. And one can note a concentration of rare events during these last years: 2001 was the record year of highest rainfalls in Paris with more than 1,000 mm of precipitation; 2003 was the year of the heat wave which killed 15,000 people in France; and in 2006-2007 following several years of droughts, the level of certain springs which supply Paris had never been so low. On the other hand, the modern tools for real time measurement of the climate and the extreme weather events in Paris will become very complex while being impacted by cumulated constraints: increased sensitivity of the Seine to discharges of pollutants, pollutant loads increase at the treatment plants due to the water pressure, possibility for pollutants loads discharges in the Seine River.

In these circumstances, compliance with environmental standards will become more difficult and can lead to put into question improvements that were achieved in recent years. More general questions also arise on broader issues: the search for technical solutions to obtain high waste water treatment performances at affordable energy cost, the search for alternatives to conventional sanitation by implementing an extraction of the chemical elements C, N, P out of the water cycle, or the possibility of lowering thresholds for environmental indicators before returning the treated water into the rivers; the latter issue if implemented being a real regression and a terrible failure.

This example is an illustration of the problems that the megacities will face. But, if the improving knowledge of water resources and the changing needs of the population are keys from promoting new solutions, it will also be necessary to analyse the way how political decisions are being taken.

These issues and many more will be the subject of an international scientific symposium dedicated to water management in megacities and global change (particularly climate change), held from December 1st to 4th 2015 in Paris and organized by ARCEAU-IDF with the support of UNESCO (http://eauemega2015.sciencesconf.org/)

O-2229-06
Assessment of climate change mitigation and adaptation strategies at the district scale

M. Musy (1)
(1) ensaNantes, IRSVT FR CNRS 2488, Nantes, France

The urban climate is on average warmer than its rural counterpart. This urban heat island (or UHI) is influenced by the corresponding urban form and materials and their impacts on the ambient temperature. The heat island impacts vegetation and byanthropogenic heat gains. In summer, heat rejection from air cooling systems can represent a substantial share of these anthropogenic gains and this is itself exacerbated by the urban heat island, since this diminishes systems' performance. On the other hand, in climates in which buildings' energy use is dominated by heating demands, the UHI reduces demands for applied energy and may, on the whole, improve pedestrians' comfort. These climate–energy–comfort relationships are complex and intertwined. Furthermore, as cities become denser, the magnitude of this UHI increases and this can have significant implications for energy use, emissions and greenhouse gas emissions, comfort and indeed for mortality; as the influence of heat waves intensified. Solutions to climate change mitigation, energy transition and climate change adaptation must thus be tackled simultaneously. The effectiveness of these solutions requires, in addition to knowledge of the relationships between climate and the thermal behaviour of buildings, the development of approaches that support predictions of energy use in the urban context and its impacts on the urban microclimate. In that context, policymakers face an increasing need to improve knowledge of environmental impacts from city planning policies and from the tools in order to assist with planning climate change mitigation and adaptation measures. This proposed contribution aims to gather and debate the state of the art regarding assessment of UHI reduction strategies, with a particular emphasis on the district scale, which is the usual urban planning and design scale.
ABSTRACT BOOK
International Scientific Conference     7-10 JULY 2015    PARIS, FRANCE

ABSTRACT BOOK

O-2229-07
A ‘Sustainability Window’ of Urban Form
S. Lohrey (1); F. Creutzig (2)
(1) Mercator Research Institute on Global Commons and Climate Change, Land Use, Infrastructure and Transport, Berlin, Germany; (2) Mercator Research Institute on Global Commons and Climate Change, Land use, transport and infrastructures, Berlin, Germany

Climate change mitigation becomes an important policy goal for cities worldwide, but local environmental objectives are equally important in policy-making. This study investigates the impact of urban form and modal shares on air pollution, greenhouse gas emissions, congestion and cost of living by using both empirical data from a number of cities, as well as a straightforward urban economics model. Denser urban form would not only unambiguously mitigate climate change, but also translate into a higher proportion of air pollution affecting citizens. We introduce a window of most sustainable urban form to highlight trade-offs between the externalities of urban form. Only a combination of transportation policies, infrastructure investment and progressive public finance enables the development of cities that meets all sustainability dimensions simultaneously. We identify a minimum urban density of 50 persons/ha to meet sustainability goals.

2229–POSTER PRESENTATIONS

P-2229-01
Promoting Sustainable Human Settlements and Eco-City Planning Approach: Southeastern Anatolia Region and Southeastern Anatolia Project (GAP)
B. Acma (1)
(1) Anadolu University, Economics, Eskişehir, Turkey

In the recent years, there have been many opportunities flourishing through the development of Turkey. One of these is unvalued rich agricultural and hydro–sources in the Southeastern Anatolia Region. The Southeastern Anatolia Project (GAP), one of the most important projects to develop the remarkable natural resources of the world, is considered as a chance to make use of rich water and agricultural resources of the Southeastern Anatolia Region.

In the recent years, the concept of promoting sustainable human settlements and eco–city planning approach has been included into the GAP Project. And, by applying these concepts in real projects caused remarkable results through development of the region.

The aim of this study is analyze the concepts of promoting sustainable human settlements and eco–city planning approach in the GAP Project that has been still processed.

In the first section, the region of Southeastern Anatolia and the GAP Project will be introduced briefly. In the second section, the stages of GAP Project and the project existing will be analyzed. In the third section, the projects and sub–projects used for promoting sustainable human settlements will be introduced.

In the last and fourth section, a series of policies and strategies for providing the process of settlements which is optimal and harmonizes with eco–system will be given.

P-2229-02
Producing nature for public: panel data analysis of public green spaces provision in Chinese cities
W. Chen (1)
(1) The University of Hong Kong, Department of Geography, Hong Kong, Hong Kong

The landscapes and infrastructures of cities have long been viewed as products of human–nature interaction. This study sheds new light on how a critical constituent of urban landscape and infrastructure, urban public green spaces, has been produced in China’s ongoing profound urbanization process. Over the past decades, China’s urbanization has been characterized by a land-based pattern centered on the commercialization and capitalization of urban land induced by the decentralization of state power. The revenues generated from urban land leasing hold the promise to empower local governments’ fiscal capacity and flexibility in financing various urban infrastructures aiming to enhance local amenities and attract external investment. This paper investigates the impact of land–based urbanization on the provision of urban public green spaces, an integrated part of urban public infrastructure, using panel data across 28 Chinese prefecture cities. The empirical results reveal a negative relationship between the reliance on land finance and the amount of urban public green spaces, indicating that local governments’ pursuit of maximizing land lease revenue will not be able to finance more public green spaces, and may even cause the loss of public green spaces. The regional variations amongst the eastern–coastal, central, and western cities confirm that an initially positive relationship between land finance and the provision of urban public green spaces at the early stage of development would reverse to a negative relationship with the increasing pace of urbanization and economic development, which may lead to a social inequity pertaining to public accessibility to urban green spaces.

A balance amongst economic growth, environmental concerns, and social equity is very much needed in the quest for sustainable development.

P-2229-03
Green roof cooling effect as climate-adaptation tool for tropical cities
CY. Jim (1)
(1) University of Hong Kong, Department of Geography, Hong Kong, China

Global warming has accentuated the urban heat island (UHI) effect in cities. Urban green infrastructures can provide ecosystem services and attendant climate–change adaptation. Many cities have urban green space (UGS) deficit due to deficient ground–level sites. Numerous building envelopes, including rooftops, facades and walls, furnish ample yet largely untapped greening opportunities. Their efficacy in mitigating climate–change impacts deserve to be investigated by empirical experiments. In compact humid–tropical Hong Kong, two green–roof and a control bare–roof plots were installed on a high–rise building. Precision temperature sensors were installed in a holistic vertical profile extending from outdoor air to roof surface, green–roof material layers, and indoor ceiling and air. The apartments under the plots were kept unoccupied to monitor air–conditioning energy consumption. The comprehensive–systematic data allowed in–depth analysis of thermal performance of vegetation (Sedum and Perennial Peanut) and weather (sunny, cloudy and rainy) in summer. The effects on temperature and humidity were measured. The results revealed that green roofs can significantly improve urban thermal performance.

P-2229-04
Building Urban Climate Resiliency and Adaptation Strategies: A Case Study of an Indian Mega Cities
S. Mandal (1)
(1) National Institute of Technology Patna, Department of Architecture, Patna, Bihar, India

India is experiencing rapid urbanisation, and consequently water demand in urban areas is escalating rapidly. Many megacities of India are located in the central part of the
Coastal landscapes have historically attracted a larger number of settlements than inland. This trend is expected to continue. Commonly, increase in coastal settlements has been accompanied by growth of existing urban areas, particularly coastal cities. Such growth is characterised by transformation from natural landscapes to impervious surfaces associated with the thermal expansion of man-made drainage systems. These interactions complicate planning for water supply and demand and increases water insecurity. Moreover, regional annual average monthly maximum temperatures are projected to increase 2.5°C by 2049, based on the ensemble average of 41 CMIP5 models and assumptions of moderate future climate change (e.g., RCP4.5; data source: http://climexp.knmi.nl). These projected increases in temperature will put further stress on water supplies, through increased demand for water, and through increased evapotranspiration. In addition, the increasing exposure to climate change, described above, will be superimposed on existing vulnerabilities, which include a lack of groundwater regulation and monitoring. Currently, Indian mega cities lack building by-laws to include a lack of groundwater regulation and monitoring. It is clear that they lack information on and understanding of projected climate change impacts.

The present study examines the nature of the aquifer system within the urban areas, the temporal changes in the recharge and discharge mechanisms of different aquifers. It also looks at associated dialogues and actions related to climate adaptation strategies about water sector in urban areas.

The purpose of this research is to understand the complex dynamics of the water sector and ultimately to suggest the resilience interventions to address these vulnerabilities and tools to support overall resilience, which are needed just to address Indian mega cities non-climate water management concerns, are necessary as a stepping-stone to transformative pathways for addressing the underlying issues associated with our common future under climate change.

P-2229-05

Urban land-cover types, thermal differences and relative vulnerability to climate change: quantification of South Africa's coastal metropolitan areas using remotely sensed data

J. Odindi (1) ; O. Mutanga (1) ; E. Abdel-Rahman (1) ; A. Elhadi (2) ; V. B. Bangamwabo (1)

(1) University of KwaZulu-Natal, School of Agriculture, earth and environmental Sciences, Pietermaritzburg, South Africa;
(2) University of The Witwatersrand, Johannesburg, School of Geography, Archaeology and Environmental Studies, Johannesburg, South Africa

Coastal landscapes have historically attracted a larger number of settlements than inland. This trend is expected to continue. Commonly, increase in coastal settlements has been accompanied by growth of existing urban areas, particularly coastal cities. Such growth is characterised by transformation from natural landscapes to impervious surfaces associated with the thermal expansion of man-made drainage systems. These interactions complicate planning for water supply and demand, and increases water insecurity. Moreover, regional annual average monthly maximum temperatures are projected to increase 2.5°C by 2049, based on the ensemble average of 41 CMIP5 models and assumptions of moderate future climate change (e.g., RCP4.5; data source: http://climexp.knmi.nl). These projected increases in temperature will put further stress on water supplies, through increased demand for water, and through increased evapotranspiration. In addition, the increasing exposure to climate change, described above, will be superimposed on existing vulnerabilities, which include a lack of groundwater regulation and monitoring. Currently, Indian mega cities lack building by-laws to include a lack of groundwater regulation and monitoring. It is clear that they lack information on and understanding of projected climate change impacts.

The present study examines the nature of the aquifer system within the urban areas, the temporal changes in the recharge and discharge mechanisms of different aquifers. It also looks at associated dialogues and actions related to climate adaptation strategies about water sector in urban areas.

The purpose of this research is to understand the complex dynamics of the water sector and ultimately to suggest the resilience interventions to address these vulnerabilities and tools to support overall resilience, which are needed just to address Indian mega cities non-climate water management concerns, are necessary as a stepping-stone to transformative pathways for addressing the underlying issues associated with our common future under climate change.

P-2229-06

Trapped in a flood-prone zone: Poverty and policy in a Tanzanian slum

L. Stark (1) ; L. Tiina-Riitta (2)

(1) University of Jyväskylä, Department of History and Ethnology, Jyväskylä, Finland; (2) University of Jyväskylä, Dept. of history and ethnology, Jyväskylä, Finland

Dar es Salaam is a coastal city with more than 70 per cent of its five million residents living in informal settlements that lack adequate infrastructure and services. Here climate change is expected to exacerbate the vulnerability of poor communities located along stormwater drainage channels through sea level rise, increased rainfall variability, and possibly more intense coastal storms. In mid-April of 2014, heavy rainfall led to the worst flooding since Tanzania’s independence in 1961, killing 21 people and leaving another 600 people dead. It also caused devastating damage to private property and public infrastructure, leaving thousands stranded and without shelter. Apart from significant loss of property and risk to human life, floods pose widespread health risks for poor residents due to latrine overflow.

Not all areas of the city are vulnerable to flooding, however. This paper will explore why the residents of the most flood-prone zones are unable to leave and move elsewhere. Our focus is on the suburb of Tandale, located five kilometres from the centre of Dar es Salaam and bordering the Ubugo-Ng’ombo river system. This river system experiences severe annual flooding during the long rainy season, and both informal home owners and renters living along its banks find themselves ‘trapped’ by chronic poverty, lacking the means to rent or purchase homes in other central urban areas (necessary to livelihood) due to rising land values elsewhere. Moreover, disaster risk in this area is exacerbated by the practice of creating landfill from solid waste along river banks to increase space for home construction. Government programs to upgrade infrastructure and formalise land tenure through residential licenses so far do not apply to flood-prone areas, and thus cannot help these residents. Our ethnographic research into residents’ experiences of flooding and the reasons for their immobility is based on in-depth, thematic interviews and observation carried out during 2010 – 2014.
2230 - Transport and climate change: mitigation and adaptation measures for transport infrastructures

ORAL PRESENTATIONS

K-2230-01

Title not communicated

A.Jullien (1)
(1) IFSTTAR, Planning, Mobility and Environment Network, France

Abstract not communicated

K-2230-02

Title not communicated

J. Harvey (1)
(1) Roads LCA, UC Davis, California, USA

Abstract not communicated

O-2230-01

Climate change mitigation and adaptation strategies in the transport sector

A. Leuxe (1)
(1) French Ministry of Ecology, Sustainable Development and Energy, Paris, France

International scientific works confirm that climate changes (IPCC, 2007). Climate change already impacts our society and economy in different sectors: energy, infrastructures, agriculture, etc. Tackling climate change is complex, as it requires participation, transversal cooperation between elected representative, scientists, the civil society, etc., and both adaptation and attenuation strategies.

Greenhouse gases emissions from transportation are likely to increase in the coming years. Thus, international policies have been decided to limit greenhouse gases emissions due to the transport sector. The French Ministry for Ecology has applied these policies and also introduced proactive policies, e.g., to better understand and quantify greenhouse gases emissions and to encourage stakeholder cooperation to reduce these emissions.

All forms of transport are affected by the impacts of climate change on transport networks. Adaptation has become vital due to the long functional lifespan of networks and transport equipment. Four actions to adapt transport have been decided in the French Climate Change Adaptation Plan. This plan, set up in 2011 and available for 5 years, results from a consultation of various stakeholders: national and local scales and then, an administrative production. Ifs four transport actions aimed at analysing the impact of climate change on transport infrastructures and networks, anticipating transport system vulnerabilities and making preparations to improve the resistance and resilience of existing and future infrastructures to ensure the continuity and safety of transport services for goods and passengers:

- action n°1: review and adapt technical standards for construction, maintenance and operation of transport networks (infrastructures and equipment) in continental France and French overseas territories
- action n°2: study the impact of climate change on transport demand and the consequences for reshaping transport provision
- action n°3: define a harmonised methodology to diagnose the vulnerability of infrastructures and land, sea and airport transport systems
- action n°4: establish a statement of vulnerability for land, sea and air transport networks in continental France and in French overseas territories and prepare appropriate and phased response strategies to local and global climate change issues

O-2230-02

Adaptation of transport infrastructures and systems to gradual climate change and to extreme climate events

M. Colin (1)
(1) CEREMA, Île de France, Sourdun, France

There is no remaining scientific doubts that climate changes (IPCC, 2007). First impacts of climate change are already being felt in numerous sectors, such as energy, agriculture, transport, etc. These impacts are predicted to increase in the coming years. The French Climate Change Adaptation Plan, implemented in 2011 and covering a five-year period, has identified actions and measures to tackle impacts of climate change in these sectors. Since transport infrastructures and systems are vital for economic and human activities and requires long-lasting investments, there is a high need of adaptation solutions. Thus, transport adaptation actions have been identified in the French Climate Change Adaptation Plan. These actions are aimed at improving resistance and resilience of transport systems to climate change. Therefore, a transversal working group with experts of various transport systems was established in 2011. The group met numerous times, among other things, to review and adapt technical standards for the construction, maintenance and operation of transport networks (action 1) and to develop a methodology of risk analysis (action 3).

A diagnostic of impacts due to long-term evolution of climate on infrastructures and on technical and normative reference documents for infrastructures conception, maintenance and operation has been done. Experts representative for all transport modes – road, bridge, rail, aeronautic, waterway, maritime mode, etc. – worked together to understand climate scenarios and to screen major long-term impacts of gradual climate changes and gradual changes of extreme weather events on infrastructures. Hundreds of technical and normative reference documents have been analysed. Documents that may be impacted by climate change have been listed and classified in categories which reflect their priority of adaptation. Climate variables that are required to adapt documents have been identified. The way forward will be to make climate projections to adapt documents and then, construction, maintenance and operation standards.

Adaptation of transport infrastructures to extreme events has also been addressed by the working group, through the development of a methodology for risk analysis. Extreme events are defined here as not easy to anticipate, localized and with high impacts on transport infrastructures and system – networks deficiency or failure and thermal, environmental, societal and economical impacts. The methodology comprises three main stages:

- analysing past and future extreme climate events – intensity, occurrence and spatial distribution, to identify climate events that are likely to impact transport;
- analysing infrastructure vulnerabilities of extreme climate events to build impacts scenarios
- analysing system functional vulnerabilities – mobility devices, accessibility, access for rescue services – to identify consequences of network disruption.

O-2230-03

A review of adaptation practices in Europe and challenges ahead

A. Aparicio (1)
(1) European Environmental Agency / Technical University of Madrid, Madrid, Spain

This presentation makes a summary of recent adaptation initiatives in the transport sector in Europe, and discusses
the key challenges ahead, based on the recent report of Europe’s adaptation agenda (http://ec.europa.eu/publications/adaptation-of-transport-to-climate). The factual information collected was based on data available in the Climate-ADAPT information platform, a literature review, case studies provided by many stakeholders, and a questionnaire on transport and adaptation addressed to EEA member countries in 2013. A total of 23 countries answered this questionnaire. Although the results obtained were based on a limited number of respondents, they provide interesting insights and encourage further analysis and discussions.

The review of experiences in Europe shows that mainstreaming adaptation into regular transport planning, and into other policies and plans, is not yet common. For example, measures planned in the context of low carbon transport like improved inter-modality offer also options for adapting transport to climate change but currently do not include it. Many tools developed for natural disaster risk management or contingency plans can easily be made relevant for climate change adaptation too. Meanwhile the adaptation focus is mostly on transport infrastructure, with little attention given so far to proof operations for future climate impacts.

Attention to adaptation remains relatively low in the transport agenda, particularly when compared to action in other infrastructures. Current focus is on early, conceptual stages and less, so far, on implementation in spite of the urgent need to consider climate change impacts in those infrastructure investments being made now. Measures may become piecemeal and spontaneous approach, and are often organised autonomously by the different stakeholders. This fragmented approach is unlikely to be efficient or to guarantee the necessary consistency to address long-term challenges. Effective adaptation of the transport system requires moving from isolated and spontaneous adaptation to integrated, complementary and mutually supportive action of the many different stakeholders involved in and outside the sector.

Climate change mitigation is strongly influencing contemporary long-term visions on transport. Future transport systems will basically remain the same we know today: in fact, innovations may phase out currently dominant mobility solutions; governance reforms could provide more participatory and transparent decision making approaches, better balancing accessibility needs and environmental footprints. In such a dynamic environment, efforts focusing merely in adapting today’s transport systems to future changes in climate could result in dedicating resources to problems that may no longer remain a priority in the long-term future, when adaptation may actually be needed. Ironically, adaptation actions with a narrow approach on today’s systems could jeopardize the transition towards low-carbon transport concepts. It cannot be taken for granted that transport systems in 30 years from today will basically remain the same we know today: in fact, influential actors, including many national governments and the European Union (e.g. in the 2011 White Paper on Transport) are actively pushing to achieve a low-carbon transport system in the long term.

Significant changes are expected within the coming years in the transport sector. These are the combined result, among allia, of changes in the root causes of transport demand, changes in accessibility needs, and the implementation of new concept. Although long-term thinking has been largely influenced by climate change mitigation considerations, adaptation has largely been absent. Integrating adaptation objectives within the current conceptual frameworks could help better identify the adequate policies, and could also help to properly assess and select the adequate adaptation actions to undertake in the short, medium and long term.

O-2230-04
Cross-border cooperation on adaptation strategies for roads in Europe

M. Grauert (1)
(1) CEDR, Copenhagen, Denmark

CEDR (Conference of Directors of Roads) is a European confederation of national road authorities (NRAs) that works on facilitating the exchange of experience and information and and to analyse and discuss all road-related issues, especially infrastructure, infrastructure management, traffic and transport, financing, legal and economic problems, safety, environment, and research in all of these areas.

Road directors of Europe (CEDR) are aware of the importance of improving European cooperation. This is a key element for making progress in the road and road transport sector and strengthening the relationship with other modes of transport and with society at large.

Addressing climate change adaptation is becoming a very important task in CEDR, as road owners see the consequences of changes as an increasing matter. Cross-border cooperation in an appointed “Task group on climate change adaptation and mitigation” has become a valuable tool to facilitate National actions outline a strategy for adapting roads to climate change.

The strategy is centered on management, improvement, prevention and cooperation, and provides specific examples on areas to consider. These include examples of information to road users, incident management, implementation through planning phases, tools for risk analyses, legislative work, research and information sharing and many others.

Likewise, a template for an action plan is provided, giving examples on how to ensure responsibility and anchor climate change adaptation in the organization and create awareness in order to actually direct the organization towards a more climate-resilient profile.

The work of the CEDR-task group is a sound example in the context on how cross-border collaborations between NRAs can yield higher benefits in transportation networking and enhanced means of climate change adaptation. A key outcome of the CEDR-work group on climate change is to provide a paradigm on composing a directly implementable strategy and action plan to every road organization, a plan which likewise will be applicable to other modes of transportation, e.g. railroads.

O-2230-05
Adaptations of road infrastructure to climate change - Selected examples from around the world (session 2230 - Transport)

T. Dubreucq (1)
(1) Ifsttar, Departement for geotechnics, environment, natural hazards and earth sciences, Nantes, France

To adapt a road to a new and specific climate affecting one country, there is first need to investigate if it is observable elsewhere in the world. And owing to exchanges in the World Road Association, geotechnical engineers can determine rules to be taken to preserve the existing road network and the precautions to design a new road. We illustrate below some specific actions of five countries: Australia, Mexico, Morocco, Malaysia and South Korea.

Unsealed roads account for most of the roads linear in the world. To climate change, better maintenance is expected to ensure their durability. Australia has produced a guide for non-specialists which contains the technical maintenance of unpaved roads, in accessible terms. The guide introduces a wearing course instead of the surface layer of a paved road. Speed limits and maximum loads are indicated. A chapter is devoted to measuring the damage of unpaved roads by means of an original measure of dust which is produced in traffic. After the rain falls, barriers are put in place on the roads, for the drying time. The life service of Australian unpaved roads is thus twenty years if the quality of building materials is respected and if the periodic road maintenance is followed (every three months in wet weather).

To repair the degradation of unpaved roads after the water floods, the Mexico infrastructure Institute has also made large-scale projects to test new soil treatment products, mainly based geopolymer. Geosynthetics can also be associated.

In the South, Morocco faces at an increasing siting of its road network. All forms of siting are encountered, and decrease the road safety. An analysis about road network and actions over several decades has been conducted.
Unfortunately it appears that this natural phenomenon is complex, non-structurable and difficult to model or control.

The practices in stormwater management on the roads in Malaysia are very interesting. Malaysia is a tropical country which receives up to 2.5 m of water mainly between November and February. The return period of rainfall for network design does not exceed ten years. The road drainage system follows the «Guidelines for the design of the road drainage» produced by the Department of Public Works and the Road Association of Malaysia. These recommendations are drawn from various repositories (AASHTO, British Standard, ...) but applied to local conditions. Malaysia has also dug in its capital Kuala Lumpur a tunnel of 9.7 km in length and 13.2 meters in diameter. The tunnel comprises a highway pavement in its upper half and a channel in its lower half. During thunderstorms, the entire tunnel can be flooded to drain all the water that flooded the city so far, of course after banning the traffic of vehicles.

South Korea has established for all its highways a national risk map and defined the types of landslides encountered. Torrential rains can reach more than 110 mm per hour. Global warming seems to cause an increase in the intensity of rainfall and mudslides and rocks on the slopes. Each highway drainage system (hydraulic structure, surface sanitation, drainage slopes, drainage trenches) has a return period well defined by geography (mountains, plains rivers). A drainage class and a flow rate calculation mode are assigned to each portion of highway depending on the extent of the watershed. Drainage system are also used to prevent the solid thrust (blocks, uprooted trees), many dams have been created.

Assessment of the impact of La Niña phenomenon over the infrastructure of transport in Santander-Colombia

J. Gutiérrez (1)
(1) Universidad de Santander, Environmental Engineering, Bucaramanga, Colombia

Extreme meteorological events associated with climate change are a real issue and have important impact over the economy of infrastructure sector, including high ways, hydrocarbon transport by pipelines, mines, etc. Because saturation of soils by water can produce landslides and it could produce the fracture of pipelines or other kind of tangible assets. For example, an assessment of historical geotechnical failures in Ecopetrol (Colombian Oil Company) vs. extreme meteorological events shows that during La Niña (extreme rainfall period) geotechnical failures are three times greater. This work shows a method to identify peaks of risk by extreme meteorological events, mainly La Niña phenomenon, with focus in most probably alteration of rainfall. Our results illustrate the hot spots where there is a high probability of slight excess (120–160% of average rainfall) and high excess (160% of average rainfall). The results have been intersected in a GIS whiit pipelines and highways with mass movement risk maps to identify the places of high risk along Santander region Colombia.

O-2230-06

Socio-technical transitions to low-carbon consumption: Developing markets for electric mobility

J. Axsen (1)
(1) Simon Fraser University, Schoole of Resource and Environmental Management, Burnaby, BC, Canada

Societal transitions to low-carbon consumption require substantial changes in technological development and consumer behavior. This study applies a socio-technical perspective to study transitions—assessing opportunities and obstacles that are political, technological and social, and how they develop and influence one another. The present focus is the deployment of plug-in electric vehicles (PEVs) in Canada, a technology that is powered by electricity solely or in part. PEVs could reduce greenhouse gas (GHG) emissions in the transportation sector, which currently accounts for 28 percent of Canada’s emissions.

The goal of this research is to characterize Canada’s readiness for a socio-technical transition to PEVs and inform national and provincial GHG policy. Key uncertainties include Canadians’ awareness, perceptions, attitudes and values relating to PEV technology. Uncertain technical constraints include consumer driving patterns, access to PEV recharge infrastructure, and the GHG-intensity of electricity sources.

Data were collected via an in-depth, multi-part consumer survey completed by representative samples of vehicle builders in Canada and vehicle owners in British Columbia (n = 112). Social readiness is assessed via questionnaire scales of awareness, attitudes, values and lifestyle. Consumers’ technical readiness is assessed via a diary of ownership assessing home electrical infrastructure. Consumers’ PEV design preferences were elicited via an innovative series of design exercises and consumers were then constructed regionally and temporally explicit models of PEV market penetration and use from disaggregated consumer data. These demand models are matched with provincial electricity generation data to estimate energy and GHG emissions impacts.

Results highlight opportunities and barriers for a transition to electric mobility. Opportunities includes findings that most car buyers already have access to some form of home based charging for these vehicles, and awareness of existing public charging infrastructure is not required to build consumer demand. Further, at least one-third want to buy some form of PEV under realistic price conditions, though patterns of preference, willingness-to-pay, and motivations differ substantially across segments of potentially early market buyers (as identified through latent class analysis).

Potential barriers include a broad lack of familiarity with PEV technology, and controversies about the true (lifecycle) environmental impacts of PEV usage. Most important is the role of strong climate policy, such as carbon pricing or regulations such as a Zero–Emissions Vehicle mandate (as implemented in California and several other U.S. states). Without such supply–focused policies in Canada, it is unlikely that a substantial transition to electric mobility will occur in the coming decades.

Knowledge of PEV impacts, readiness and policy priorities is highly valuable to policymakers considering PEV deployment to meet GHG goals, as well as electric utilities, urban planners and automakers. These results also enhance knowledge regarding the social and technical challenges of low-carbon societal transitions.

P-2230-02

Science-policy-stakeholder dialogues about Low Carbon Strategy in the Colombian Freight Transport Sector

A. Cadena (1); R. Delgado (1); M. Espinosa (1); C. García (2); C. Obando (2); F. Marquez (3); JM. Sandoval (4); R. Suarez (4)
(1) Universidad de los Andes, Bogotá, Colombia; (2) Unidad de Planeación Minero Energética, Bogotá, Colombia; (3) Ministerio de Transporte de Colombia, Bogotá, Colombia; (4) Ministerio de Ambiente y Desarrollo Sostenible de Colombia, Bogotá, Colombia

Colombia as other southern countries has undertaken a serious process for the statement of national post 2020 mitigation scenarios. We have identified and evaluated a package of more than 100 mitigation options by estimating abatement potential and costs. We have proposed sectoral mitigation plans finally adopted by government. A delightful dialogue process has been undertaken with a wide participation of industry, academy and government in order to get a consensus (design and cost). Mitigation Actions Plans were adopted by government ministries.

This process was conducted under the Colombian Low Carbon Development Strategy (CLCDS). The dialogue was part of the MAPS project (Mitigation Action Plans and Scenarios), coordinated by SouthSouthNorth (SSN). Similar processes were adopted in the Long Term Mitigation Scenarios project in South Africa, as well as in the Low Carbon Strategies in Brazil, Chile, and Peru.
Commitments have been achieved in almost all sectors with modest but tangible results in agricultural, power end energy, and industry sectors. Transportation of passengers and freight have showed huge difficulties to decouple their growth from energy use and emissions. Energy demand in Colombia in 2015 in road transportation accounted for 38% of final energy demand. Total GHG emissions were 218 Mton CO2e and transportation sector accounted for 10.5% of total emissions.

Diesel and gasoline are the main fuels used in road transportation. Either fuels account for more than 85% of the total consumption in this sector. The National Energy Plan for Colombia states that the introduction of compressed natural gas (CNG) was initially used only by public urban passenger transportation vehicles (taxi cabs and buses). In recent years there has been an increasing number of vehicle conversions (automobiles and small trucks) from gasoline to CNG due mainly to high oil prices. As a result, CNG consumption has increased. Right now the country has a huge availability of Liquefied Petroleum Gas and representatives of the industry are looking for opportunities to increase its participation in the transport business.

We discuss the following questions in this paper: Why should Colombia change its energy matrix in freight transportation? How is it able to respond quickly and effectively to climate change? How can one convince people to segregate e-waste disposals and Clean Development Mechanisms. In the Guide to Climate Change adaptation in Cities (2011) (1) University of Asia and the Pacific, Asia-Pacific Studies, N. Pokharel (1) (1) Tribhuvan University, Environmental Science, Lalitpur, France

P-2230-03

Challenges and Opportunities in Climate Change Adaptation of Coastal Cities: Lessons in the Adaptation Road Maps of Metro Manila and Singapore

PM. Paje (1)
(1) University of Asia and the Pacific, Asia–Pacific Studies, Pasig City, Metro Manila, Philippines

The Guide to Climate Change Adaptation in Cities (2011) published by the World Bank considers a city resilient if it is able to respond quickly and effectively to climate change impacts. The same guide contends that a resilient city's adaptation strategies should be integrated into its own disaster risk reduction and sustainable development policies. To get the public engaged and committed to embrace the concept of adaptation however is fraught with difficulty (2). This paper presents the challenges as well as the opportunities that these two coastal mega-cities in southeast Asia have. As Coleman, Offenheiser, and Waskow (2009) embrace the concept of adaptation however is fraught with difficulty. The road to climate change adaptation indeed is long and winding. Dessler and Parson (2010) consider climate change to go beyond the issue of the environment making it a serious and difficult matter to manage. But, as climate change poses inevitable challenges, it also offers opportunities in carbon trading through the Clean Development Mechanisms. This is the context that frames this policy analysis of the roadmaps of Metro Manila and Singapore in climate change adaptation towards their goals of becoming resilient cities in Southeast Asia. This analysis presents the challenges as well as the opportunities that these two coastal mega-cities in Southeast Asia have.

Adaptation of cities involves initiatives and measures whether formal or informal that leads to resilience against climate change impacts. Singapore is quite unique being an island city-state. Metro Manila on the other hand is a microcosm of the nation–state it serves as a capital and major city. A glaring disparity exists between the two in terms of political regimes, economic and social development. In terms of scale the adaptation response of Metro Manila presents the challenges as well as the opportunities that these two coastal mega-cities in southeast Asia have. This analysis of the roadmaps of Metro Manila and Singapore in climate change adaptation indeed is long and winding. Dessler and Parson (2010) consider climate change to go beyond the issue of the environment making it a serious and difficult matter to manage. But, as climate change poses inevitable challenges, it also offers opportunities in carbon trading through the Clean Development Mechanisms.

P-2230-04

A Study on Climate Change Impacts: Adaptation Measures for the Hilly Road construction: Case of Nepal

N. Pokharel (1)
(1) Tribhuvan University, Environmental Science, Lalitpur, France

Nepal encompasses 85% of its land as hilly and mountainous area. Out of total 80,000 km road construction within the country only 1800km is with blacktopped. The steep slopes with fragile geology are the characteristics of the hilly region. Geologically Nepal lies on Himalayan area with the mobility of Tibetan and Indian Plate. So the vulnerability seems higher. The Impacts of climate change focused on water resource. The Himalayas towers are one of the source of rivers and rivulets. The rivers and rivulets are flowing from north to south up to Gangas River in India. The road and transportation sector requires to cross the rivers and return periods for the floods and extreme rainfall. The rate of a city's expansion in terms of territory and population is directly proportional to the increase in the rate of a city's expansion in terms of territory and population. This analysis of the roadmaps of Metro Manila and Singapore in climate change adaptation indeed is long and winding. Dessler and Parson (2010) consider climate change to go beyond the issue of the environment making it a serious and difficult matter to manage. But, as climate change poses inevitable challenges, it also offers opportunities in carbon trading through the Clean Development Mechanisms.

The road transport sector is a key area that contributes to climate change by way of greenhouse gas emissions. However, the transport sector is in turn itself affected by climate change. Higher groundwater levels associated with extreme precipitation will super an increased risk of landslides on excavated slopes. There is a risk that the bearing capacity of bridge and tunnel foundations,
supporting walls and sheet piling will be reduced by increased groundwater levels. This can be found in number of ways, especially for foundations on sand. Modern safety installations are significantly more sensitive to temperature increases than older installations and this may presents a particular problem. Autonomous adaptation to climate change is important because of the complexity and long lifetime of road. Furthermore, improved maintenance in the form of cleaning existing road drainage systems can retain drainage capacity corresponding to that of a new installation.

Whilst, transport systems and infrastructure designed to withstand typical weather patterns, climate change impacts arising in the near and longer-term can have an impact on the efficiency of transport operations and ability of infrastructure to withstand extreme events.

The designs of project road have been done considering the potential effects of climate change. From a road development perspective in Nepal, impacts of climate change mainly takes the form of concentrated high rainfall resulting in the accelerated surface run-off from slopes and increased flows in gullies, drainage channels, streams, and rivers. These phenomena have a consequent effect on the stability and performance of road sections, bridges, and other structures.

P-2230-05

Is electric mobility a driver to climate mitigation in the EU-27 countries? Myths and realities from energy systems analysis

J. Seixas (1); L. Dias (1); S. Simões (1)
(1) Faculdade Ciencias e Tecnologia – Univ Nova de Lisboa, Caparica, Portugal

In many research and policy fora, electric vehicles (EV) are considered effective alternatives to passenger mobility due to their contribution to CO2 mitigation, when compared to internal combustion engines, mainly if the power comes from renewables. Recent research [1] showed that for an EU-wide greenhouse gas emission reduction cap of 40% and 70% by 2050 vis–à–vis 1990 emissions, battery electric vehicles (BEVs) are cost-effective in the EU only by 2030 and only if their costs are 30% lower than currently expected. Vehicle costs and the capability to deliver both short- and long-distance mobility are the main drivers of BEV deployment. Other drivers include national mobility patterns and the cost-effectiveness of alternative mitigation options, both in the transport sector, such as plug-in hybrid electric vehicles (PHEVs) or biofuels, and in other sectors, such as renewable electricity.

A bottom-up partial equilibrium 36 multi-region model (PET36) representing these countries’ energy systems linked through trade of the main energy forms was used. PET36 is driven by exogenous country-specific energy services demand and the evolution of energy prices, endogenous energy potentials and policy assumptions. Its main output is the cost-effectiveness mix of energy supply and demand technologies across seven EU economic sectors (e.g., oil and bio refineries, natural gas distribution pipelines), electricity and heat generation, industry, residential, commercial, agriculture and transport. This model allows us to get in depth insights on the system transformation of each EU–27 country to deliver cost-effective BEVs for passenger mobility up to 2050. We use two families of scenarios, shaped by varied EU level emission caps and BEVs cost curve.

Our presentation relies on results just published [1] and goes a step further, focusing on:

- (a) confronting the national plans of each EU country on EV adoption with current status (actual deployment) and the results from our analysis, aiming to discuss the expectations and failures of electric mobility deployment in each EU country and the current and future role of public policy to overcome current barriers and risks;
- (b) assessing the reduction of greenhouse gas emissions in each EU country due to adoption of BEVs and PHEVs taking into account the whole energy system, i.e., not only the shift from internal engine combustion to electric engines, but also the shift in the power sector and refineries. The goal is to discuss the impact of electric mobility policy measures on the transformation of energy system, including trade-offs, co-benefits, risks and feedbacks.

We argue that the energy system analysis used in this research is the appropriate approach to discuss the impact of mitigation policies. Across Europe, as well as in other regions, electric vehicles are seen, both by climate policy makers and car markets, as a panacea for the mitigation of a significant share (up to 40%) of greenhouse gas emissions. However, detailed analysis at EU member state level shows that the adoption of this technology is far from expected. Vehicle costs and the capability to deliver both short- and long-distance mobility are the main drivers of BEV deployment. Other drivers include national mobility patterns and the cost-effectiveness of alternative mitigation options, both in the transport sector, such as plug-in hybrid electric vehicles (PHEVs) or biofuels, and in other sectors, such as renewable electricity.

We argue that the energy system analysis used in this research is the appropriate approach to discuss the impact of mitigation policies. Across Europe, as well as in other regions, electric vehicles are seen, both by climate policy makers and car markets, as a panacea for the mitigation of a significant share (up to 40%) of greenhouse gas emissions. However, detailed analysis at EU member state level shows that the adoption of this technology is far from expected. Vehicle costs and the capability to deliver both short- and long-distance mobility are the main drivers of BEV deployment. Other drivers include national mobility patterns and the cost-effectiveness of alternative mitigation options, both in the transport sector, such as plug-in hybrid electric vehicles (PHEVs) or biofuels, and in other sectors, such as renewable electricity.

A bottom-up partial equilibrium 36 multi-region model (PET36) representing these countries’ energy systems linked through trade of the main energy forms was used. PET36 is driven by exogenous country-specific energy services demand and the evolution of energy prices, endogenous energy potentials and policy assumptions. Its main output is the cost-effectiveness mix of energy supply and demand technologies across seven EU economic sectors (e.g., oil and bio refineries, natural gas distribution pipelines), electricity and heat generation, industry, residential, commercial, agriculture and transport. This model allows us to get in depth insights on the system transformation of each EU–27 country to deliver cost-effective BEVs for passenger mobility up to 2050. We use two families of scenarios, shaped by varied EU level emission caps and BEVs cost curve.

Our presentation relies on results just published [1] and goes a step further, focusing on:

- (a) confronting the national plans of each EU country on EV adoption with current status (actual deployment) and the results from our analysis, aiming to discuss the expectations and failures of electric mobility deployment in each EU country and the current and future role of public policy to overcome current barriers and risks;
- (b) assessing the reduction of greenhouse gas emissions in each EU country due to adoption of BEVs and PHEVs taking into account the whole energy system, i.e., not only the shift from internal engine combustion to electric engines, but also the shift in the power sector and refineries. The goal is to discuss the impact of electric mobility policy measures on the transformation of energy system, including trade-offs, co-benefits, risks and feedbacks.

We argue that the energy system analysis used in this research is the appropriate approach to discuss the impact of mitigation policies. Across Europe, as well as in other regions, electric vehicles are seen, both by climate policy makers and car markets, as a panacea for the mitigation of a significant share (up to 40%) of greenhouse gas emissions. However, detailed analysis at EU member state level shows that the adoption of this technology is far from expected. Vehicle costs and the capability to deliver both short- and long-distance mobility are the main drivers of BEV deployment. Other drivers include national mobility patterns and the cost-effectiveness of alternative mitigation options, both in the transport sector, such as plug-in hybrid electric vehicles (PHEVs) or biofuels, and in other sectors, such as renewable electricity.

A bottom-up partial equilibrium 36 multi-region model (PET36) representing these countries’ energy systems linked through trade of the main energy forms was used. PET36 is driven by exogenous country-specific energy services demand and the evolution of energy prices, endogenous energy potentials and policy assumptions. Its main output is the cost-effectiveness mix of energy supply and demand technologies across seven EU economic sectors (e.g., oil and bio refineries, natural gas distribution pipelines), electricity and heat generation, industry, residential, commercial, agriculture and transport. This model allows us to get in depth insights on the system transformation of each EU–27 country to deliver cost-effective BEVs for passenger mobility up to 2050. We use two families of scenarios, shaped by varied EU level emission caps and BEVs cost curve.

Our presentation relies on results just published [1] and goes a step further, focusing on:

- (a) confronting the national plans of each EU country on EV adoption with current status (actual deployment) and the results from our analysis, aiming to discuss the expectations and failures of electric mobility deployment in each EU country and the current and future role of public policy to overcome current barriers and risks;
- (b) assessing the reduction of greenhouse gas emissions in each EU country due to adoption of BEVs and PHEVs taking into account the whole energy system, i.e., not only the shift from internal engine combustion to electric engines, but also the shift in the power sector and refineries. The goal is to discuss the impact of electric mobility policy measures on the transformation of energy system, including trade-offs, co-benefits, risks and feedbacks.

We argue that the energy system analysis used in this research is the appropriate approach to discuss the impact of mitigation policies. Across Europe, as well as in other regions, electric vehicles are seen, both by climate policy makers and car markets, as a panacea for the mitigation of a significant share (up to 40%) of greenhouse gas emissions. However, detailed analysis at EU member state level shows that the adoption of this technology is far from expected. Vehicle costs and the capability to deliver both short- and long-distance mobility are the main drivers of BEV deployment. Other drivers include national mobility patterns and the cost-effectiveness of alternative mitigation options, both in the transport sector, such as plug-in hybrid electric vehicles (PHEVs) or biofuels, and in other sectors, such as renewable electricity.

2231: Cultural Heritage facing up to Climate Change, Sea Level Rise and Pollution

ORAL PRESENTATIONS

O-2231-01

Creation and evaluation of future indoor climate and risk maps for European cultural heritage buildings and their interior

M. Winkler (1) ; F. Antretter (1) ; R. Kilian (2) ; J. Leissner (3)
(1) Fraunhofer Institute for Building Physics IBP, Valley, Germany; (2) Fraunhofer Institute for Building Physics IBP, Cultural Heritage Reserach, Valley, Germany; (3) Fraunhofer Gesellschaft zur Förderung der angewandten Forschung, Brussels, Belgium

In the EU-funded Climate for Culture (CfC) project, an interdisciplinary research team of 27 partners investigated the impact of expected future climate change on Europe’s cultural heritage buildings and their interior collections. Thereby regional climate models and building simulation tools were coupled to assess the outdoor and indoor implications. Two different climatic scenarios, A1B and RCP 4.5, from the 4th and 5th IPCC-report were used as baseline for the projection of future outdoor climate data. The regional climate modeling tool REMO was applied for high-resolution simulations of outdoor climate over Europe and the Mediterranean for both climatic scenarios. These calculated climate indices were used as input for the METEO tool, which is based on measurements of existing buildings collected during the CfC project. These Generic Sacred Buildings were placed on 474 locations all over Europe and the Mediterranean. The regional climate models and building simulation tools were coupled to simulate indoor climate for three time-windows: 1960 – 1990, 2020 – 2050 and 2070 – 2100. Afterwards, each indoor climate, in particular temperature and relative humidity, was evaluated by using a new developed automated method which assesses nearly 200 parameters, like for example...
O-2231-02

Long-term damage of climate and pollution on the stone and glass in Paris

RA. Lefèvre (1) ; P. Brimblecombe (2) ; M. Déqué (3) ; C. Grossi (4) ; A. Ionescu (5)

(1) Université Paris-Est Créteil, LISA, Paris, France; (2) City University of Hong Kong, School of Energy and Environment, Kowloon, Hong Kong; (3) Météo France – CNRS, Centre national de recherches météorologiques, Toulouse, France; (4) University of East Anglia, School of environmental sciences, Norwich, United Kingdom; (5) Université Paris–Est Créteil, Certes, Créteil, France

The urban fabric is affected by both climate and air pollution, but the magnitude of their impact varies over time. The effects of air pollution on the degradation and soiling of materials were particularly noticeable during periods of rapid urbanization, while the late 20th century has seen a reduction as a result of the decline in the aggressive pollutants such as sulphur dioxide. Soiling is more complex than there have been changes in the nature of the deposited particles over time, but as with the gaseous pollutants there have been improvements that accompanied more stringent regulations designed to improve air quality. Over the centuries there has been an increase and subsequent decrease in the rate of damage to building materials which can be interpreted in terms of the environmental Kuznets curve. The decline in the aggressiveness of pollutants in Paris makes it likely that climate driven processes will on balance play a bigger role in the future. Historically frost damage was important, but it is hardly likely to be relevant in a warmer future. This presentation attempts to estimate the rates of recession and soiling of calcareous stone and damage to glass and stained glass in Paris over many hundreds of years and understand how these processes will change through to the end of the 21st century. The long term variation of air pollution is assessed on the basis of past observations and estimated for the future from likely regulatory trends. Meteorological input derives from historical data and some non-instrumental weather records, while future climate is adapted from the Hadley Centre and Météo–France models under a2, RCP2.6 and 8.5 scenarios for the 21st century. Computational models to long term in damage has used dose–response functions from a range of sources to estimate the magnitude of the changes and where possible compare these with historical observations of the state of buildings made by architects and other observers.

O-2231-03

Quantitative Nuclear Magnetic Resonance Imaging, Profiling and Diffusometry on Fluorinated Compounds to Preserve Cultural Heritage Porous Media and Safe for the Environment

L Brizi (1) ; M. Camaiti, (2) ; P. Fantazzini, (1)

(1) Centro Fermi, Roma, Italy, University of Bologna, Department of Physics and Astronomy, Bologna, Italy; (2) Centro Fermi, Roma, Italy, National Research Council, Institute for geosciences and hearth resources, Florence, Italy

The preservation of historical buildings and outdoor cultural heritage is a necessity to hand down to the future works of art, as well as to sustain an important economic resource. The main causes of degradation of stones, one of the most important porous materials of these artifacts, are related to the chemical–physical processes that influence the ingress and diffusion of water (liquid or vapor) into the pore space. It is well known that water dissolves CO2 and pollutants from the atmosphere, causing acidic corrosion of the stone or the binder, and it is responsible of internal mechanical stresses due to freezing–thawing cycles or salt crystallization.

For the treatments, usually hydrophobic compounds (typically synthetic polymers) are applied, with performance (efficiency and durability) that depends on the compounds used, the treatment procedure and the chemical–mineralogical nature of the substrate. Many are characterized by fast action and guaranty good performance: high stability (chemical, thermal and to photo–oxidation), high adhesion to the mineral substrate (interaction must not be chemical), low surface tension, and suitable molecular dimensions, which allow a uniform distribution, good penetration into the porous structure, and low propensity to pore blockage. Very important is the solubility of the product in solvent safe for man and environment. Perfluoropolymers, applied on some historical buildings since the 1980s, have high stability, water repellency and low surface tension, but the protective treatment showed a low durability. Perfluoropolymers containing polar group able to improve air quality, typically ester and amide groups, were developed. Unfortunately, these compounds are soluble only in CFC and in supercritical CO2, therefore their use as protective agents for historical stone artifacts was abandoned since the 1995.

This work was focused on the preparation of a new protective agent with low average molecular weight containing short pendant perfluoropolymer segments linked to an oligosuccinamide chain in order to achieve: (i) good hydrophobic behavior and photo–stability, (ii) good adhesion to the rock through the polar amide groups, (iii) excellent distribution on the pore walls surface without their blockage, (iv) solubility in environmental friendly solvents.

Hydrophobic penetration and distribution properties of the compound applied on a biocalcarenite (Lecce stone), have been investigated by Nuclear Magnetic Resonance (NMR) Imaging, Profiling and Diffusometry of 1H nuclei, and compared with a perfluorinated commercial product. These NMR techniques have been proved to be a valid non-destructive and non-invasive technique for monitoring the conservation state and water absorption in materials and objects of interest to cultural heritage, as well as for evaluating the efficiency and distribution of protective or consolidation treatments.

The results obtained by Imaging were compared with those obtained by single–sided NMR analysis, the last instrument, that allows for in situ non-destructive analyses, was equipped with a lift for automatic shift of the NMR sensor and allowed us to obtain high spatial resolution profiles of the investigated POLs. Two–dimensional correlations maps of the two parameters self–diffusion coefficient and NMR relaxation time gave further information on the performance of the treatments. These results demonstrates that the oligosuccinamide satisfies the main properties required to a protective agent (no color changes of the treated surface, high residual permeability and high photo–oxidation stability), and improves the water repellency of treated stone surfaces in respect to a fluoroelastomer, frequently applied as protective agent and here used as reference.
Urban planning and design to mitigate climate change impact: the role of heritage conservation in a dense urban city

EHK. Yung (1)
(1) The Hong Kong Polytechnic University, Department of Building and Real Estate, Hong Kong, China

Climate change and global warming has made urban heat island effects become more severe in cities facing rapid urbanization. The urban heat island phenomenon is even more severe in urban cities with the tall and massive high-rise building morphology. In contrast, built heritage sites consist usually of low rise buildings located in city centres. The conservation and adaptive reuse of historic buildings can provide potential breathing space among the high rise building blocks to generate air patterns and minimize the heat island effect. Thus, the careful planning and design of heritage sites can enhance human thermal comfort and mitigate the adverse impact of climate change in the dense urban cities, whilst preserving historic pride and cultural spot.

Climate change also alters the way that people live, work, worship or socialize in public space. What role can built heritage play in minimizing the adverse impacts of climate change on the microclimate of the urban environment? Conservation and Planning considerations should emphasize more on clusters of heritage sites in urban districts which can provide much greater impact on the overall urban environment than a single building.

This paper explores the relationship between climate change mitigation and built heritage conservation in a dense urban city. It is proposed that a robust database of spatial maps will be constructed, of an urban districts in Hong Kong with the aid of GIS. The study maps will display the urban fabric including the locations of heritage sites, building height and mass, building footprint and use, open space, and topography. Micro-climate environmental maps which include temperature, and wind velocity will also be compiled. Field measurements of the meteorological parameters at the selected studied heritage sites will provide supplementary data for the spatial maps.

Despite the robust maps and measurement are important, the ways in which conservation of heritage buildings can influence the social experience of adapting to climate change would be worth for investigation. The impact of climate change is not restricted to physical and environmental impacts, in fact, the socio-economic changes due to climate change will have also have a great impact on the conservation of cultural heritage. One hand, this study attempts to shed light on the ways that people, in relation to the environment they live, work, worship and socialize in buildings, sites and landscapes with heritage values. For example climate change modifies the social interaction patterns in public spaces. On the other hand, heritage can also affect the social experience of climate change. Heritage conservation can have a positive effect on the lives of people in a changing climate and how they perceive climate change. For example, a green common space in a heritage site can provide the community with a pleasant breathing space in the middle of high rise buildings.

Thus, it is of paramount importance to examine the extent to which the adaptive reuse of heritage buildings can also incorporate design considerations which mitigate the physical and social effects of climate change. This proposed research will help towards responsive and innovative solutions to the UHI effects and climate change with the conservation and reuse of heritage buildings. A better understanding of the impacts of built heritage, urban morphology and the surrounding microclimate is essential to create successful climate change mitigation strategies for dense cities.

The study will provide useful reference data for urban planners and urban designers helping them to incorporate environmental and social considerations on the conservation of heritage buildings, and most importantly, help to ensure the better use of heritage sites to mitigate climate change adverse impacts in dense urban cities.
O-2231-06

Multi-Criteria Accuracy Assessment for Indoor Climate Change Projections of Historic Buildings

R. Kilian, (1); H. Brandl, (2); F. Antretter, (3); M. Krus (3); K. Sedlbauer, (4)

(1) Fraunhofer Institute for Building Physics IBP, Cultural heritage research, Holzkirchen, Germany; (2) Fraunhofer Institute for Building Physics IBP, Preventive conservation and heritage preservation, Holzkirchen, Germany; (3) Fraunhofer Institute for Building Physics IBP, Hygrothermal building analysis, Holzkirchen, Germany; (4) Fraunhofer Institute for Building Physics IBP, Director, Holzkirchen, Germany

Recently hygrothermal simulation has been applied for the projection of damage risks from future indoor climate in historic buildings. This has been done using generic weather data obtained from dynamic downsampling of regional models with different global climate change scenarios (A1B and RCP4.5). The objective of this paper is the development and definition of new concepts to assess the accuracy of hygrothermal simulation models for indoor climate of historic buildings in the contexts of climate change and preventive conservation. Preventive conservation is aimed at the permanent preservation of objects of cultural value by improving ambient conditions and by reducing or minimizing relevant risks. The quality of simulation models is of significant importance especially when assessing climatic risks in historic buildings with precious interior and works of art, since misjudgements of planned measures can result in irreversible damages. Moreover, hygrothermal simulation models offer new opportunities for calculating the effect of different measures to improve indoor climate. But also for the assessment of future risk it is important to know how reliable a simulation model is for the present. Therefore, it is important to develop criteria to assess the results of simulation with regard to preventive conservation, and to verify them by means of case studies. The indoor climate of the small village church St. Margaretha in Bavaria is characterized in detail by means of measured data and reproduced by means of simulation models. For this case study a new approach was developed using multiple criteria in the form of different damage functions for accuracy assessment. This assessment is only one important element in the chain of uncertainties that applies when using projected future climate data from global climate change projections. Therefore also the measured long-term outdoor climate from a weather station nearby has also been compared to the generic weather data for the recent past (1960–1990) for different climate change

O-2231-07

The balance of air pollution and climate as drivers of damage to heritage

P. Brimblecombe, (1)
(1) City University of Hong Kong, School of energy and environment, Kowloon, Hong Kong

It has been well known from classical times that weather and smoke cumulatively damage buildings. The shifting climates of the past had an impact and historic exposure to aggressive air pollutants, especially those from coal which caused not merely smudging but led to surface recession and crust formation that resulted from high sulfur dioxide concentrations. The situation has changed as air pollution is more effectively regulated. Our understanding of the impact of air pollution on damage requires an understanding of material or heritage climatologies that recognise the role of the combination of meteorological factors, cycles of climate and the long accumulation of damage. Although controversy surrounds long-term climate predictions, there seems little doubt that the world will become warmer and rainfall patterns will change, even if we cannot be sure of the magnitude. The changes are often quite small, just a few degrees change in temperature or percentage changes in rainfall or relative humidity. This means amplification is often necessary for the effects to be significant. Phase changes (freezing or salt crystallisation) can be important amplifiers, while biological effects (changing insect numbers or rapid fungal growth) can also enhance the outcomes from small temperature changes.

The impact of changed rainfall can be increased by a larger number of wet days or longer times of wetness. The frequency of extreme events may also alter the rate of material damage. Air pollutants will doubtless be more regulated in the future, but new problems may arise through the presence of ozone and diesel compounds in the air and novel pollutants might also have an impact.

O-2231-08

Socio-cultural implications of Climate Change for Cultural Heritage

M. Cassar (1)
(1) University College London, UCL Institute for Sustainable Heritage, London, United Kingdom

When considering the interaction between cultural heritage and climate change, the most media-visible effort on climate change is undoubtedly scientific research. Yet society requires science to have wider context and meaning. It needs to be relevant. Therefore the socio-cultural impact of climate change must be part of any discourse on the implications of climate change for cultural heritage.

Not only would this inform our understanding and influence our response to climate impacts. It would, for society, make our response more resilient and sustainable. There are inherent cultural and social dimensions to climate change. Artists and sculptors, writers and poets, performers and other cultural practitioners engage the public with climate change in ways that are necessary and important. They provide critical pathways for adaptation. The arts and humanities, social sciences and economic disciplines provide different lenses through which to develop new responses to life-changing events. By developing a range of perspectives, we improve our chances of co-creating sustainable survival strategies.

Cultural heritage research until recently, has been largely concerned with the impact on ancient and historic materials and assemblies such as those caused by increasing sea levels and floods, changes in the moisture contents of the air and in the conditions of soil (especially for archaeological sites) and migration of pests. Yet cultural heritage is more than stones, bricks and mortars.

In addition to these impacts, climate change can severely affect the sustainable conservation of cultural heritage places by altering the traditional way of life of communities. The relationship of communities to their landscape, their work and social habits, can be affected by the rapid deterioration of physical assets and loss of authenticity.

In 2008, World Monuments Watch and the World Monuments Fund provided dramatic evidence of these consequences when it listed a number of places at high risk of loss due to the effects of climate change. These included:

- Herschel Island, Canada (from rising sea levels, eroding coastline and melting permafrost);
- Scott’s Hut and the Explorer’s Heritage, Antarctica (from warming triggering large amounts of precipitation leading to microbial infestation and decay);
- Sonargaon–Panam City, Bangladesh (from the low-lying terrain making it especially vulnerable to flooding and rising sea levels);
- Leh Old Town, India (from changing weather patterns in the Himalaya bringing more rain in the summer thus creating problems for the flat mud roofs designed for the originally dry climate);
- Kilwa Historic Sites, Tanzania (from serious rapid deterioration of the archaeological and monumental heritage due to erosion and vegetation caused by rainwater wash accentuating the risks of collapse of the remaining structures on the edge of the cliff); and
- Chinguetti Mosque, Mauritania (from effects of the expanding desert, changing rainfall patterns, vegetation loss, soil erosion and extreme temperatures).

If scientific research is to understand deeply the cause and effect of change on cultural materials, and if it is to develop sustainable adaptation strategies, the values associated with these places need to be integral to the solution. This
ABSTRACT BOOK

ABSTRACT BOOK

Physics IBP, Hygrothermal building analysis, Valley, (Cnr), padova, italy; (4) Fraunhofer institute for Building and Climate (isaC) - Italian national research Council

should the protected area be extended? is this protected may be dated even when they do not contain organics. the produce new information. so there is an always wider and new dating techniques regularly appear and help to scientific knowledge about ancient processes is limited included into the wide and general notion of heritage? Our can ancient human induced erosion processes may be soil erosion. the context of the object is as important as when sea level was different) and the ancient events which be protected (or reconstructed) should not only be the museum but as a site they cannot be understood outside the "natural" environment at the moment of their building. the other set of heritage sites is totally different. Most of vey different from their possible inclusion into a museum collection.

The first step has been to calculate the outdoor climate (e.g. precipitation, dryness, temperature, humidity, time of wetness, repeated freezing/thawing, salt crystallization cycles), then the indoor climate and finally the potential risks to collections, paintings, furniture etc. the potential of mechanical, chemical and biological agents will depend on the outdoor climate change, the building structure and the material type. In order to know the expected changes and assess risk factors, the EU funded "Climate for Culture" project has been used to highlight the significance of these endangered problems, aims, solutions, and building use. these

O-2231-09

Protecting coastal heritage from coastal rapid events: Epistemological issues

H. Regnault (1)
(1) Université de Rennes 2 et Institut Universitaire de France, Laboratoire costel, umr letg, Rennes, France

Coastal heritage is comprised of many different types of artefacts. Some of them are located along the coast but have no direct relation with the sea (such as tombs, stones circles). Others (for example harbours, fisheries, dykes, shell middens...) do present a deep relation with the sea level, the wave directions, the local winds and possibly with sediment movements. The first group of heritage sites may be be determined by relative sea level rise and/or coastal retreat and beg for a protection. Though these archaeological objects may be moved inland and still keep most of their scientific value and cultural interest. In this case their landward shift and protection is not very different from their possible inclusion into a museum collection.

The other set of heritage sites is totally different. Most of their scientific value depends on their precise relation with the “natural” environment at the moment of their building. As objects they can be deconstructed and stored in a museum, but not the site itself. The site, on the contrary, is deeply linked to a specific morphological setting where they were built. In these two cases the epistemological issues are clearly different. Though a large part of the scientific value is located inside of the object itself (it is a real property of the object, as realists philosophers have often explained) some other dimension of the scientific knowledge is not in the object but in the relation it has with the local passed environment, and especially with the local ancient morphodynamic condition. Therefore what should be protected (or reconstructed) should not only be the object but the natural ancient environment (the local site when sea level was different) and the ancient events which may have taken place such as storms or human induced soil erosion. The context of the object is as important as the object itself. This rises new questions about heritage and cultural approaches of heritage conservation. How can climatic events be understood as heritage? How can ancient human induced erosion processes may be included into the wide and general notion of heritage? Our scientific knowledge about ancient processes is limited and new dating techniques regularly appear and help to produce new information. So there is an always wider range of objects which can be dated: with Pb 210 muds may be dated even when they do not contain organics. The question of how large is the accommodation space around the artefact is totally opened: how far from the object may the phenomenon that provide relevant information? How far should the protected area be extended? Is this protected space compatible with other activities on the coast?

This speech present some pre roman examples in Brittany and some post cold war examples in Taiwan.

O-2231-10

Outdoor-Indoor climate relationships for Cultural Heritage

D. Camuffo (1); J. Leissner (2); C. Bertolin (3); F. Antretter, (4); M. Winkler (4); L. Kotova (5); U. Mikolajewicz (6); A. Bock, (7); T. Bichler, (7); M. Winkler (6); G. Lefjonhufvud (10); J. Ashley-Smith (11); D. Jacob (12)
(1) Consiglio Nazionale delle Ricerche, Istituto di scienze del clima e del atmosfera, Padua, Italy; (2) Fraunhofer Gesellschaft, Zurich Forschung, Brussel, Belgium; (3) Istituto di Oceanografia e Climatologia (ISC – Italian National Research Council (CNR), Padova, Italy; (4) Fraunhofer Institute for Building Physics IIB, Hypothermal building analysis, Valley, Germany; (5) Climate Service Center 2.0, Helmholtz center for geesthacht, Hamburg, Germany; (6) Max Planck , Institute für Meteorologie, Hamburg, Germany; (7) Technical University, eindhoven, Netherlands; (8) Technical University, Eindhoven, Netherlands; (9) Uppsala University, Gotland, Sweden; (10) Uppsala University, Department of art history, Uppsala, Sweden; (11) JAS, Cambridge, United Kingdom; (12) HZG/Climate Service Center 2.0, Hamburg, Germany

Not only historical buildings and outdoor monuments are exposed to climate change and related risks. The exchanges of air, heat and moisture through the building envelopes will affect the indoor climate too, with potential risks to collections, paintings, furniture etc. The potential impact of mechanical, chemical and biological agents will depend on the outdoor climate change, the building structure and the material type. In order to know the expected changes and assess risk factors, the EU funded "Climate for Culture" project has been used to highlight the significance of these endangered problems, aims, solutions, and building use. these

The analysis of the research shows that climate change may have negative, neutral or positive impacts (e.g. slower deterioration rates, more or less need for heating, cooling or humidifying) depending on specific problems, aims, solutions, and building use. These results offer a framework for daily practice and mitigation strategies, or to take advantage from the positive aspects, when possible. In this sense, this project provides an informative tool aimed to assist policy makers, conservators, architects and other users, in view
The Climate for Culture outcomes as tool for energy planning strategies and preventive conservation against mould, pests and other challenges in the Alpine region

C. Bertolin (1); D. Camuffo (2); F. Antretter, (3); M. Winkler (3); L. Kotova (4); D. Jacob (5); A. Van Schijndel (6); H. Schellen (7); T. Vyhialad (8); T. Brostrom (9); R. Kilian, (10); J. Leissner (11)

(1) Consiglio Nazionale delle Ricerche, Istituto di scienze dell’atmosfera e del clima, Padua, Italy; (2) Consiglio Nazionale delle Ricerche, Istituto di scienze dell’atmosfera e del clima, Padua, Italy; (3) Fraunhofer Institute for Building Physics IBP, Chemical Service Center 2.0, Helmholtz center geesthacht, Hamburg, Germany; (5) HZG/Climate Service Center 2.0, Hamburg, Germany; (6) Technical University, Eindhoven, Netherlands; (7) Technical University, Eindhoven, Netherlands; (8) Czech Technical University, Prague, Czech Republic; (9) Uppsala University, Gotland, Sweden; (10) Fraunhofer Institute for Building Physics IBP, Kulturbeforschung, Valley, Germany; (11) Fraunhofer Gesellschaft zur Förderung der angewandten Forschung, Brussels, Belgium

In the times of climate change, a global imperative is to save energy and reduce our carbon footprint. Museums and other cultural institutions are deeply implicated in these concerns as major consumers of energy, particularly heating and ventilation systems often housed in modern buildings. The demand for a better understanding of the interactions between cultural heritage collections and the climate and future perspective of energy consumption are pressing. The current state of knowledge highlights the need to develop strategies for protection and adaptation which requires specific risk assessment not only in the short but in medium and long term. Above all such risk assessment shall be focused on the correspondent building type and geographic location of the end user to provide a scientific support in planning target interventions in terms of lower energy consumption and cultural heritage protection.

This intervention exploits and analyzes the data developed within the EU-funded research project Climate for Culture (CfC) before and after the 2009–2014 to assess, in the Alpine region, the future energy consumptions of HVAC systems as well as the specific risks of mould, pest infestation and freezing–thawing cycles leading to damage on the building envelope, quality of control, quality of envelope, windowed area, thickness and construction materials.

The CfC project, over the past five years, has investigated the influence of current and future climate change on cultural heritage objects (Kilian et al. 2013; Leissner et al. 2013 and 2014). This large scale EU research project has now made available for a wide community of stakeholders scientific knowledge, technological innovation and new data concerning future indoor projections of thermo-hygrometric and HVAC energy consumption from regional climate models in a range of generic and exemplary buildings. In particular the data which generate the Climate for Culture maps, supported by other CfC outcomes results, are recommendations to minimize energy consumption, preservation strategies and the exDSS software for implementing the decision support system, provide unique and useful tools for helping stakeholders in implementing energy saving and preventive conservation intervention strategies in their area of interest in advance.

The purpose of this work is to create an exemplary data analysis focused on the Alpine region, to help final users in exploiting CfC results as tool to assess in which extension the impact of the ongoing climate change will affect a specific geographic area over the near (2021–2050) and the future (2071–2100). The results will be analyzed in term of energy saving and risk management strategies.

References:


We estimate the salt weathering in 44 locations uniformly distributed in France, applying the obtained regression to meteorological data from 44 stations and to future model data at the same locations obtained from climate models. All the past data come from Météo-France stations from 1971 to 2000 and future data from simulations of Arpege model for 2071 to 2100, A1b scenario. The final goal was to classify the different salt weathering behaviours in different regions. For each station we calculate the mean, max, min and standard deviation of the number of transitions (NaCl and Na2SO4) or the number of days (CaSO4) obtained from the polynomial regression functions. After that we apply an Ascending Hierarchical Classification to the data to classify the different locations. The results show that for past data 3 different “salt behaviour” classes are well differentiated but for future data the classification is more complex and does not correspond to the actual one. In general, we can distinguish three geographic areas in a N-W to S-E direction. In the Northern part weathering by NaCl and Na2SO4 will remain constant or slightly decrease but gypsum effect will be more important. In the central part, covering most of the France, salt weathering will increase for the three salts and in the southern part, NaCl and Na2SO4 salt weathering will increase but gypsum weathering will decrease.

2232 - The Copernicus Climate Change Service: an European answer to Climate Change Challenges

**ORAL PRESENTATIONS**

K-2232-01

Europe’s Eyes on Climate Change
P. Brunet (1)

(1) European Commission, Dir. of aerospace, maritime and defence industries of dg grow, Bruxelles, Belgium

Climate change is a major global challenge with a range of potential social and economic impacts and the need for adequate adaptation and mitigation actions. The changes of our climate are growing increasingly urgent. Copernicus, through its new thematic service, will support policymakers and relevant public authorities in monitoring the changing climate in order to better understand its potential effects and take appropriate actions. To illustrate the effort dedicated to this operational programme, a total budget of EUR 5.9 billion has been allocated to the Copernicus programme (including the satellites), EUR 900 million thereof are dedicated to the six services. The importance of the climate change is reflected by the allocation of EUR 2.15 billion (almost a quarter of the services budget) to the Copernicus Climate Change Service (C3S). This service will bring together and integrate many different sources of information about the Earth, including data from the dedicated and operational Sentinel satellites and information from the other Copernicus services monitoring our oceans and ice masses, our atmosphere, and the Earth’s land surfaces. The study of climate change involves a wide range of stakeholders and different scientific disciplines. Consequently, the C3S will be inherently cooperative, collaborative and international. Copernicus aims at becoming a trusted reference source for climate-related information and will become Europe’s main contribution to global efforts to better understand and monitor our planet’s natural systems. The C3S products will comprise ECVs (Essential Climate Variables), a set of key variables identified by GCOS for monitoring and predicting climate change, as well as Climate indices and Indicators required to address sector specific issues. Amongst the first sectors to be taken up by the pre-operational service are domains of particular interest, for instance water management and energy. Based on the ECVs and the indices and indicators tailor-made products will be developed integrating geophysical data with ancillary data on population, infrastructures, industrial assets, transport, etc. These products will support the holistic assessment of proposed climate policy measures for different possible scenarios for future developments. The Copernicus Climate Change Service is ready to begin operations in a phased approach, starting with a proof-of-concept and the pre-operations. The service is implemented by the European Centre for Medium-range Weather Forecasts (ECMWF) and other Copernicus services (C3S), same session] The service will embody a comprehensive operational climate change monitoring system, which will continue to evolve in line of, and in close cooperation with, existing European and international initiatives, projects and activities, which it will complement with integrated modelling, reanalysis and observation capabilities.

O-2232-01

The Copernicus Climate Change Service (C3S)
JN. Thepaut (1)

(1) ECMWF, Research, Reading, United Kingdom

This presentation will provide an overview of the C3S:

This service will combine observations of the climate system with the latest science to develop authoritative, quality-assured information about the past, current and future states of the climate in Europe and worldwide. The service will benefit from a network of observations, both from in situ and satellite sensors, and modelling capabilities. Moreover, it will provide key indicators on climate change drivers (such as carbon dioxide) and impacts (such as reducing glaciers).

The service will deliver substantial economic value to Europe by (1) informing policy development to protect European citizens from climate-related hazards such as high-impact weather events, (2) improving planning of mitigations and adaptation practices for key human and societal activities, (3) promoting the development of new services by providing datasets and tools following an open and open data policy.

The talk will review the expected portfolio of C3S products and datasets which include consistent estimates of multiple Essential Climate Variables, global and regional reanalyses (covering a comprehensive Earth-system domain: atmosphere, ocean, land, carbon), products based on observations alone (gridded; homogenised station series; reprocessed Climate Data Records), a near-real-time climate monitoring facility, multi-model seasonal forecasts and climate projections and scenarios at global and regional scales.

This wealth of climate information will be the basis for generating a wide variety of climate indicators aimed at supporting adaptation and mitigation policies in Europe in a number of sectors including (but not restricted to) energy, water management, agriculture and forestry, insurance, health tourism, infrastructure, disaster risk reduction, coastal areas). The service will be fully operational by 2018, and continually and independently evaluated and improved, to ensure that C3S represents the latest developments in climate science and that innovative service elements are introduced reflecting current research. Appropriate channels and interfaces with Research and Innovation activities in Europe will be established to ensure an efficient transfer from research to operational climate service related activities.

O-2232-02

How is the climate changing? Climate monitoring based on observations
D. Dee (1)

(1) ECMWF, Reanalysis, Reading, United Kingdom

Earth observations, recorded over time by a multitude of instruments ranging from early mercury barometers to synthetic aperture radars and other advanced satellite sensors, contain the fundamental information at our disposal to describe in detail how the climate has changed.
since the pre-industrial age. Observations contain the evidence that the Earth surface is warming, glaciers are melting, sea-level is rising and the oceans are acidifying. Observations allow us to monitor and assess more subtle changes taking place in our environment related to air quality, regional rainfall patterns and the occurrence of extreme events. Observations provide the foundation for developing and testing the Earth-system models and prediction systems that are needed to help us understand our common future.

An important challenge for the Copernicus Climate Change Service is to improve access to observables and to the tools needed to render them useful for climate science and climate services. A dedicated Climate Data Store is being developed for this purpose, with a catalogue to include climate reanalysis, measurements from space, homogenised and reprocessed climate data records, model-based climate reanalyses and information about data quality and uncertainties. The reanalysed data sets, constructed by combining climate observations from multiple sources with state-of-the-art models, provide the most comprehensive view of the changing climate. They contain time series of many essential climate variables, pertaining to the atmosphere, land surfaces, oceans and cryosphere, that extend back by decades or more. Continental improvement of climate reanalyses with complete and consistent descriptions of the Earth system at global and regional scales will be key to the success of the Copernicus programme.

O-2232-03
Climate prediction and projections in support of climate services
S. Planton (1)
(1) Météo-France, CNRM, Toulouse, France

One main basic component of climate information disseminated by climate services are future climate predictions and projections. Either used directly or through sectorial impact analyses, future climate simulations are needed to understand adaptation strategies or to evaluate the efficiency of climate policies. Long-term forecasting is already developed at the European and at the international level, with some applications that are already useful in different socio-economic fields, like in the energy sector, either at mid or tropical latitudes. Climate projections, from global to regional scale, are already feeding services within the context of national climate services all around the world with a very large spectrum of potential applications. We will give some insights on the usefulness of climate predictions and projections within the context of evolving requirements coming from the user community. We will give specific attention on the uncertainty issue with the common practice for climate prediction and climate change projection consisting in using multi-model ensembles of simulations putting some constraints on the climate services construction.

O-2232-04
The impacts of climate change - Sectoral applications
R. Vautard (1)
(1) Laboratoire des Sciences du Climat et de l’Environnement, Saclay, France

Climate change, its current and future foreseeable impacts have been assessed in the 5th IPCC report. Beyond mitigation, necessary to keep climate warming at a manageable level, the report pinpoints the need for adaptation for coping with unavoidable consequences. However most manageable impacts are expected in several decades, which is sometimes too far a horizon, with a number of uncertainties, to easily foresee businesses in a sustainable market for adaptation.

The talk will present exemplified areas where impacts of climate change present sufficient evidence and challenges to be implemented in a public service like de Copernicus Climate Change Service. It will also review, for a few cases, new challenges for science, and the need for even basic science to support climate change services. These examples will cover classical sectoral areas such as water, energy and health. It will also develop from a few examples how extreme events and their impacts, as a consequence of climate change, and their attribution could, after overcoming several scientific and communication challenges, be fully part of a public climate change service. The presentation will also develop the challenges for modelling but also for monitoring the earth, and particularly the impacts of climate change.

O-2232-05
How to inform policy-makers? Supporting and enabling evidence-based policy-making
G. Barker (1)
(1) Department of Energy and Climate Change, Former minister of state for climate change (2010–2014), London, United Kingdom

As we get closer to the UNFCCC legally-binding international climate change agreement set to be agreed in Paris in December 2016, policy-makers needed to be equipped with evidence-based information to assist them in determining future strategies to address climate change challenges. Developing and improving the science is one thing; making it available to its intended users and presenting it in a format and language which will actually assist policy-making are today’s challenges. We have identifies three main areas to discuss:

- Language and visualisation - though the evidence is scientific, the language should be adapted to its intended users - how science-literate are policy-makers anyway?
- How to translate uncertainty in policy-making? One of the UNFCCC core principle is that national governments should err on the side of precaution in the face of scientific uncertainty. How do we justify this approach to citizens?

Policy-making cannot satisfy itself with a ‘one size fits all’ approach and needs a sectoral approach to help target strategies and policies to each specific industry.
Modeling of the vulnerability of «biomass energy» sub-sector to climate change in Togo

K. Kouami (1)
(1) Faculty of Sciences, Botany, Togo, Togo

Biomass energy accounts for 80% of total energy consumed in Togo. But its potential decreases exponentially as a result of population growth and the fact that the techniques of production and consumption are still archaic and do not take into account the parameters of climate change. The aim of this work is to contribute to the assessment of vulnerability and adaptation to climate change in the sub-sector of biomass energy in Togo by a modeling approach. Specifically, it is i) to study the evolution of the household demand for fuelwood and ii) to analyze the vulnerability to climate change of the sub-sector of biomass energy (mainly charcoal and firewood) in Togo. Distributed lag non-linear models (DLMs) allow for a flexible estimation of the time course of the effect size of weather variable over time on the outcome.

The results show a harvesting effect of high temperatures on the outcome and a negative correlation between rainfall and malaria related daily mortality. The results show a high positive correlation between usage of seasonal rainfall forecast, lack of information on its content and climate change. It is not clear whether smallholder farmers are using seasonal rainfall forecasts in planning for adaptation activities. The paper calls for greater understanding of the determinants and constraints to application of seasonal rainfall forecast by small holder farmers in the region.

Seasonal Rainfall Forecasts and Climate Change Adaptation Among Smallholder Farmers in South West Region of Nigeria

A. Onwuemele (1)

Climate change is undoubtedly one of the most serious environmental threats facing mankind worldwide. It affects almost all sectors in agriculture (crop, livestock, pastoralism, fishery, etc) due to the high reliance on weather and climatic elements in agricultural practices. In the south west Nigeria, crop production is the dominant agricultural activity among smallholder farmers and is the primary means of their food security. This enterprise is currently faced with the challenges of changing climatic conditions. The smallholder farmers in south west Nigeria are highly vulnerable to climate change due to their general weak capacity to adaptation and this vulnerability is worsened by their heavy practice of rain fed agriculture. Recent evidence from the Nigerian Meteorological Agency [6, 7] indicates that the climate of the south west region of Nigeria is already changing based on the assessment of the climate over the period 1941 to 2000. This is manifested in changes in seasonal rainfall patterns and more unpredictable, severe and frequent extreme events like floods and droughts threatening livelihoods among smallholder farmers in the region. This scenario is having significant impacts on crop yields and product quality as a result of changes in temperatures, moisture, air and soil. To a large extent, the smallholder’s farmers in the region have continuously been adapting to changing weather conditions. Although the increasingly erratic climate variability and the rapid pace of other drivers of change are overwhelming their capacity to adapt. Consequently, the need to explore new methodologies to mitigate the effects of climate change and understand the contribution of climate variability in the region have become more critical than ever before among smallholder farmers. The use of seasonal rainfall forecasts may be an important adaptation to a more dynamic climate using case-study valuable insight into future weather and climate variability. While seasonal rainfall forecasts can serve as a potential tool for adaptively managing agricultural systems in response to climate change, it is not clear whether smallholder farmers in south west Nigeria are receptive to innovations such as the use of seasonal rainfall forecasts in planning for adaptation activities. This paper evaluates the applicability of seasonal rainfall forecast in climate change adaptation as well as the determinants and constraints to application of seasonal rainfall forecast in climate change adaptation among smallholder farmers in south west Nigeria. Simple purposive sampling was used to select Oyo State out of six states in the south west Nigeria while agricultural communities that are prone to climate change in the state were also purposively selected. Primary data were obtained from 425 farmers using questionnaire and two Focus Group Discussions (FGDs) were conducted for men and women smallholder farmers in the communities. The data obtained were organized in Microsoft Excel, cleaned and analyzed on the Statistical Package for Social Sciences (SPSS) using descriptive and inferential statistics while the FGD were content analyzed. Results indicated poor understanding of the application of seasonal rainfall forecast in planning for adaptation in the study area. Results further show that only 12.7 per cent of respondents had access and utilize seasonal rainfall forecast in planning adaptation activities. It further identified the main constraints to the non application of seasonal rainfall forecast to include poor access to seasonal rainfall forecast, lack of information on its content as reported by 49.8% of the respondents. The results show a high positive correlation between usage of seasonal rainfall forecast and educational attainments, income, ownership of ICT facilities as well as membership of local community groupings. The paper calls for greater enlightenment programmes and the integration of local medium in the communication of seasonal rainfall forecast in the region for effective access and utilization of seasonal rainfall forecast by small holder farmers in the region.
PLACARD: building a platform for CCA and DRR cooperation by 2020

M. Pulquieri (1); T. Capela Lourenço (1); P. Pringle (2); R. Schwarze (3)
(1) Faculty of Science, University of Lisbon, Lisbon, Portugal; (2) UK Climate Impacts Programme, School of geography and the environment, Oxford, United Kingdom; (3) UFZ, Leipzig, Germany

Significant challenges exist towards strengthening the Climate Change Adaptation (CCA) and Disaster Risk Reduction (DRR) communities for coherent, mutually and pragmatically planning and action. While efforts to increase complementarity continue, much work is still required to coordinate and integrate the two domains. Within the complex landscape of research and policy initiatives of these two areas various international and European efforts have been undertaken to better integrate CCA and DRR, and thus minimize the current and future risks presented by climate change in the context of extremes. Paradoxically, the past decade has seen a major fragmentation of CCA and DRR agendas, particularly at the level of research, policy, knowledge and practices. International frameworks, political processes, funding mechanisms, information exchange fora and practitioner communities have largely developed separately and operated in isolation from one another.

PLACARD is a newly funded Horizon 2020 European project that seeks to support the coordination between these two communities. PLACARD will tackle current challenges by: 1) providing a common ‘space’ where CCA and DRR communities can come together, share experiences and create opportunities for collaboration; 2) facilitating communication and knowledge exchange between both communities; and 3) supporting the coordination and coherence of CCA and DRR research, policy and practice. PLACARD’s approach to achieving these goals is to establish a strong and operational network of networks by connecting to existing networks and boundary organisations, to foster dialogue among stakeholders (e.g. researchers, research funders, policymakers, practitioners) engaged in CCA and DRR at the international, European, national and sub-national scales. This overarching network will enable these communities to share knowledge, to discuss challenges and to jointly co-produce options to bridge the gaps they experience. It will support the development and implementation of a research and innovation agenda to make better use of research funding, as well as to develop guidelines to strengthen relevant institutions in their efforts to mainstream CCA and DRR.

Adoption as Adaptation! Long-term consequences of cyclone disaster in coastal Bangladesh

Z. Sultana (1); B. Mallick, (2)
(1) Coastal Research Foundation (CRF), Environmental science discipline, Khulna university, Khulna, Bangladesh; (2) Vanderbilt University, Political science, Nashville, United States of America

Disaster risk reduction strategies and adaptation practices vary from region to region and community to community, for example, the practices of southern part of Bangladesh are different from the northern part. The sustainable disaster risk reduction strategies or adaptation practices of one region may be not be replicable to another region or community but the learnings from each strategies can introduce a new one that is adoptable to the other region. Therefore, this research aimed at to identify the short-term and long-term adopted strategies that are practicing after a devastated cyclone in southwest coastal Bangladesh. It is given that, in coastal areas people live under the constant threats of natural hazards. Thus raise the questions: how the people react to the risk of those natural calamities and how they adapt with the adverse situations that derived by those calamities. Particularly, this research has empirically explored community level practices in agriculture, housing, food, communication and employment generations in Bangladesh.

The empirical research was designed with a mixed-methods approach: (1) content analysis of face-to-face interview of 145 respondents by using semi-structured questionnaire with selected social groups and their households’ assistants; (2) contingent debates concerning the local attitude and perception for the improvement of their livelihood, which was understood as a case-study of livelihood complexities in coastal areas. Therefore, Focus Group Discussion (FGD) was conducted with three different groups: farmers, fishermen and general people. Key informant interviewers (KII) were: chairman of the Union, Upazila Agricultural officer, Upazila Fisheries Officer, NGO Representatives. Sector wise disaster risk reduction strategies and adaptation practices were recognized by the discussion with the FGD participants.

Results show that people have to start cultivating saline tolerant rice and vegetables on raised homestead instead of traditional rice varieties, as a consequences of saline intrusion after cyclone Aila. They were using dripping irrigation methods and rain water harvesting and artificial aquifer tube-well were introduced for water management. Mud wall of the houses were replaced by or even built newly with Goran wood or bamboo sticks. They have to start forming groups to save money for next disaster and taking credit for small entrepreneurship. Due to the crises of fodder, pastureland and freshwater people was forced to rear small animals and birds like sheep, goat and pigeon instead of cow and buffalo rearing. New technology based shrimp farming also has been started.

Besides, an external aid must not be the only solution to increase the coping capacity of a community, and thus to increase a resilient one. Likewise, the measures/strategies are identified that were taken by various actors based on their existing socio-economic conditions and both positive and negative impacts and outcomes of the strategies are discussed. The pros-and-cons of each adopted strategies states the interests of the different actors behind the respective strategy. It also explore that such adopted strategies in the long-run will be seen as traditional form of adaptation option for them. This study is therefore be of importance for regional planners and policy makers help to develop a comprehensive disaster management plan that will be helpful in building resilience in the affected communities.

Early Warning Systems - seamless between Disaster Risk Reduction and Climate change Adaption

J. Thielen-Del Pozo (1); P. Barbosa, (1); L. Feyen, (2); P. Salamon, (1); MJ. San (1); J. Vogt, (1)
(1) European Commission Joint Research Centre, Institute for Environment and Sustainability, Ispra, Italy; (2) JRC, Ispra, Italy

Our climates change continuously, due both to natural causes and as a result of human activities. There is a growing consensus in the scientific and policy communities that the consequences of worldwide industrialisation and rapid urbanisation are also affecting our climates. Increase in global temperature may have impact on frequency and intensity of extreme weather events, sea level rise, as...
which is to providing in pre-operational timely and a prototype of a European Drought Observatory (eDO) of six operational services under the EU Copernicus space forest fires. Both EFAS and EFFIS have become integral part of the European Parliament and the forest fire in Europe. EFFIS provides the European Commission aims at providing harmonized information on forest fires which will be illustrated in the presentation: the way people think and act. The paper presents results of two socioeconomic scenarios that were developed using insights from stakeholders and decision-makers of the City of Lienz as well as scientific findings from available data sets and the literature, i.e. a "boom" and a "bust" scenario. Categories of drivers of socioeconomic scenarios discussed during the scenario workshop cover inter alia institutions and socio-political frameworks, demographics, production and demand, markets and trade, scientific and technological innovations, and value-added systems. Based on empirical data on local employment we identified 6 relevant sectors of the local economy with specific trend developments that served as framework to discuss 2 scenarios: 1) "boom" scenario 2) "bust" scenario. Categories of drivers of socioeconomic data and projections as well as a summary of perceived current climate-related risks were presented. The latter were gathered by subjective expert reasoning (personal interviews) with stakeholders from the region. Participation thus incorporated a two-way information exchange, from science to practice and from practice to science. The presentation will finally give a perspective on the development of the climate related risk management tool.

O-2233-05

GIS-based Climate Change Vulnerability Assessment of the Municipality of Del Carmen, Surigao del Norte Province, Philippines

D. Racelis, (1) ; E. Racelis (1) ; A. Limpiada (1)

(1) University of the Philippines Los Banos, College of Forestry and Natural Resources, College, Laguna, Philippines

A GIS-based mapping and assessment was conducted to determine the vulnerability to the impacts of climate change and climate risks of ecosystems, communities, and infrastructures in the Municipality of Del Carmen, Surigao del Norte Province, Philippines. The study involved collaboration with bio-physical and socio-economic survey teams in undertaking qualitative and quantitative assessment of resources and their capacities against climate-related hazards. It also included assessment of past and present impacts of climate change vulnerability in the project areas and assessed and prioritized adaptation strategies, and identified gaps/needs in the implementation of the selected strategies.

Approximately equal number of hectares are exposed to either high (6,340 ha) or low risk (6,039 ha) to drought. For cultivated lands, Brgy. Bagakay has the largest area exposed to high risk with 1,186 ha of uncultivated lands. In particular, Brgy. San Fernando has the largest area exposed to high risk with 1,186 ha of uncultivated lands. For cultivated lands, Brgy. Bagakay has the largest area exposed to high risk with 2,322 ha. In terms of exposure, Brgy. Mahayahay has the highest with 100% of its land area exposed to high risk. In contrast, Brgy. Caub and Brgy. Lobogon have the lowest exposure to the risk.

O-2233-04

Participatory socioeconomic scenario development as building block of a local risk management tool to climate change adaptation - an Alpine test-site in the East-Tyrol, Austria

L. Meyer (1) ; B. Eder (2) ; A. Hama (1) ; M. Leitner (1)

(1) Austrian Institute of Economic Research – WIFO, environment, energy, agriculture, Vienna, Austria; (2) AlP5, Innsbruck, Austria; (3) AlP5 Centre for Climate Change Adaptation, Innsbruck, Austria

In Austria as elsewhere, extreme events such as heavy precipitation, storms, debris flows and floods are expected to show fundamental changes with respect to magnitude, frequency and duration caused by climate change. Today’s risks associated with climate change are mostly still understood and analyzed in a sector- and hazard-specific and rather static, dynamic, scenario-based way. The project ARIS (Adaptation and Decision Support via Risk Management Through Local Burning Embers) develops a decision support system for climate-sensitive iterative risk management as a key adaptation tool for the local level. One of the building blocks of ARIS are socioeconomic scenarios that capture main features of the future local economy. Regional socioeconomic scenarios are the pillars to identify future climate related risks and thus to reduce disaster risk. The local climate action framework supports the building of resilience and adaptation capacities at the local level. The scenarios are based on the current state and trends of sector developments in employment and value creation. The City of Lienz and its surroundings in the East-Tyrol. They include drivers such as demography, a story line and a vision into the future. Scenarios were developed using a participatory approach. Participatory approaches are increasingly recognized as an important element of management and decision-making. There are various reasons why to pursue a participatory approach. For instance, problems in science’s work are often not linear, but complex, and occur in many different domains and disciplines; participation is said to be a process of collective learning that changes the way people think and act. The paper presents results of two socioeconomic scenarios that were developed using insights from stakeholders and decision-makers of the City of Lienz as well as scientific findings from available data sets and the literature, i.e. a "boom" and a "bust" scenario. Categories of drivers of socioeconomic scenarios discussed during the scenario workshop cover inter alia institutions and socio-political frameworks, demographics, production and demand, markets and trade, scientific and technological innovations, and value-added systems. Based on empirical data on local employment we identified 6 relevant sectors of the local economy with specific trend developments that served as framework to discuss 2 scenarios: 1) "boom" scenario 2) "bust" scenario. Categories of drivers of socioeconomic data and projections as well as a summary of perceived current climate-related risks were presented. The latter were gathered by subjective expert reasoning (personal interviews) with stakeholders from the region. Participation thus incorporated a two-way information exchange, from science to practice and from practice to science. The presentation will finally give a perspective on the development of the climate related risk management tool.
Further, analysis shows that around 137 ha of populated areas which is about 1% of the total land area of the municipality of Del Carmen are exposed to very high risk to flood-induced landslide. These areas are mostly located in Brgys. Caub, Mahayahay, Quezon, San Fernando, and Tuburan. Likewise, about 1,644 ha (14%) of populated areas are also exposed to such risk. Further, around 31 ha and 79 ha of populated areas have moderately high to moderately low risk to landslide, respectively. However, it should be emphasized that more than 8,792 ha (77%) of the area have no risk to landslide. Further, the safest area as far as risk to landslide is concerned is Brgy. Del Carmen with virtually no areas exposed to the hazard.

Moreover, around 143 ha (1.1%) of the municipality are exposed to low to medium risk to storm surge. These are obviously confined to coastal areas. Brgy. Del Carmen has the largest area exposed to medium risk with 49.3 ha while Brgy. San Fernando has 1,024 ha of unpopulated areas exposed to the same risk. Spatial analysis also shows that Brgys. Conchoy, Lobogon, Mainrang, PaDaga, Pacaran, and Tuburan are areas are exposed to medium risk to storm surge. The condition is due to the fact that these barangays are mostly located in the higher elevation section of the municipality.

2233-POSTER PRESENTATIONS

P-2233-01

A model of choice under uncertainty for flood preparedness intention in Brazil

G. Guedes (1); R. Raad (2); L. Vaz (3); M. Araujo (4)
(1) Federal University of Minas Gerais, Department of Demography, Belo Horizonte, Minas Gerais, Brazil;
(2) Federal University of Minas Gerais, Department of economics, Belo Horizonte, Brazil;
(3) Federal University of Rio de Janeiro, Department of economics, Rio de Janeiro, Brazil;
(4) Federal University of Minas Gerais, Department of statistics, Belo Horizonte, Brazil

This paper performs an econometric analysis based on selected dimensions of the Protective Action Decision Model (PADM). For this purpose, empirically estimated preventive preparedness determinants by using Seemingly Unrelated Regression models. PADM survey instrument validation was based on Cronbach alpha, inter-rater agreement index, factor analysis, and mean-comparison tests. The PADM was applied to a representative sample of 1,200 households in the municipality of Governador Valadares, State of Minas Gerais. The site was chosen because river flooding is an apparent threat in the area, reaching thousands of households along the river. Its urban environment has undergone dramatic change in the last decades, creating an ideal scenario for flooding: riparian deforestation, river siltation, urbanization and expansion, garbage and sewage discharge into the river. In addition to the econometric analysis, event calendar of major floods in the area, also collected in the survey, allows for comparison between intended and actual preparedness behavior. Building on models of private insurance, we provide a theoretical framework stating that risk aversion is a key factor affecting the allocation of resources among households to adaptive and preventive behavior. Thus, for a given nominal budget constraint an increase in insurance price can change one’s risk aversion, leading to a higher propensity to buy insurance. We found that, under certain conditions on risk aversion, hazard-related attributes (HRA) positively affect propensity to take protective actions. This was confirmed by our regression results. In contrast, resource-related attributes (RRA) positively or do not affect propensity to adopt protective actions. This non-intuitive finding can be justified by our theoretical framework: risk averse individuals would feel relatively deprived with increase in the opportunity costs of action, leading to additional effort to take protective actions against flood hazard. Finally, the impact of HRA was empirically higher than RRA on preventive behavior since the effective cost of preventive actions is related to an individual’s budget constraint. These findings suggest that public action should promote educational campaigns aiming the reduction of subjective uncertainty on resource effectiveness.

P-2233-02

The Power of Communication in Post Disaster Reconstruction and the Implication for RIA: A Cross Country Synthesis

EKH. Lin (1)
(1) Academia Sinica, Research Center for Environmental Changes, Taipei, Taiwan

This research presents a research project funded by International START secretariat, and earlier co-sponsored by International Social Science Council and Integrated Research on Disaster Reduction (IRDR). The project is built on the RIA model and Action working group of IRDR and further examines the effects of communication across scales and social entities that might influence personal decision in the arena of post disaster reconstruction and resettlement phases. The ontology of the conceptual framework pertinent to this project views risk interpretation and decision making as dynamic and interactive. Based on the rationale, we develop an analytical framework to investigate the higher level of legislative, institutional and political structures that determine the scale of engagement and the relationships among the governed stakeholders in the policy making processes, with the lower level of norms and values that not only frame the essence of the society but also inherent in the personal interpretation about certain risk of interest. With the factors addressed in the RIA model in the cross scale communication dynamism. A three-staged hierarchical research design is thus developed corresponding to these research inquiries in the case studies across five countries, namely Taiwan, Philippines, Uganda, Honduras, and India. The research results of the cross country synthesis are displayed at governmental and institutional level and at the community or individual level that really come along with the provisional pathways for analyzing communication influences throughout the processes.

At the governmental and institutional level, it is found that the robustness of the legislative and institutional framework to regulate engagement and participation of civil society is fundamental for strengthening the influences of communication on policy making processes; at the community level, factors addressed in RIA model in the cross scale communication dynamism. A three-staged hierarchical research design is thus developed corresponding to these research inquiries in the case studies across five countries, namely Taiwan, Philippines, Uganda, Honduras, and India. The research results of the cross country synthesis are displayed at governmental and institutional level and at the community or individual level that really come along with the provisional pathways for analyzing communication influences throughout the processes.

P-2233-03

Modelling Agricultural Risk in India from an Insurance Perspective

T. Osborne (1); R. Hohl, (2); A. Boissonnade, (3)
(1) Asia Risk Centre, Reading, United Kingdom; (2) Asia Risk Centre, Singapore, Singapore; (3) Asia Risk Centre, California, United States of America
Crop insurance scheme (WBCIS) and the yield-based modified National Crop Insurance Scheme (mNAIS). With the anticipated growth, annual agriculture insurance premiums are likely to reach USD 1 billion making India the third or fourth largest agriculture insurance market globally.

With the increasing complexity of the weather and yield indices pricing WBCIS and mNAIS portfolios has become a challenge for insurers. Key constraints for robust risk modeling and exposure management are i) the lack and availability of consistent weather data and ii) the low resolution or incomplete time series of historical yield data which often show strong trends depending on the crop type, region and season. For mNAIS, insurance terms are based on data for the year or the last five years of historical yield data and payouts are triggered if actual yields are 10–20% below expected (insured) levels. In areas where large yield shortfalls have not been observed in the last 11–15 years, insurance terms are not triggered. Weather conditions are mainly driven with historical climate variations. The short historical time series, extreme events such as the 1987 or 2002 droughts cannot be effectively captured by statistical methods. Based on the short historical time series, the risk management of the crop model is then driven with historical climate variations. The model parameters are adjusted to reflect the risk potential, especially for systematic events such as droughts, floods and cyclones. The model is then driven with historical climate variations.

In this paper, the study was carried out in Balasore and Kendrapara districts of Odisha, India which are more prone to disasters. Government Organizations and NGOs engaged in disaster management directly or indirectly were interviewed in order to have broader views and opinions on policy matters, problems, opportunities and potentials and to evaluate their roles in that particular area. Open and close-ended questions were used for this purpose. A SWOT analysis was used to focus on the strengths and weaknesses of collaboration in relation to efficiency, capacity building, quality and accountability. The study found that the effective collaboration is lacking between Government and NGOs at local level. Majority of the respondents were not satisfied with the existing mechanism of collaboration in relation to efficiency, capacity building, quality and accountability.

This paper presents results of research undertaken by Asia Risk Centre to assess insurance losses of mNAIS portfolios in India. A crop model is developed using key parameters such as high-resolution gridded weather data, soil types and structure, slope coefficients, irrigation levels and crop-specific growing season parameters. To generate synthetic yields for the last 45 years the model is then driven with historical climate variations. The model parameters are adjusted to reflect the risk potential, especially for systematic events such as droughts, floods and cyclones. Based on the short historical time series, extreme events such as the 1987 or 2002 droughts cannot be effectively captured by statistical methods. Based on these results, yield indices are processed to calculate insurance losses to mNAIS portfolios after consideration of original policy terms and conditions.

This paper reveals how synthetic yields allow a quantitative and robust assessment of i) the profitability levels of a given mNAIS portfolio and growing season and ii) the expected losses from historical extreme events such as the 1987 and 2002 drought events. Synthetic yields of wheat and rice in Uttar Pradesh are compared to historical yields. The results show that the model is able to accurately represent climatically-driven variability in yield. Further, outputs of crop models in general are discussed in terms of benefits for the insurance sector including improved risk assessment, risk pricing, risk transfer and risk management and how simulated weather events can be used in crop models to generate several hundreds of years of synthetic yield series.

P-2233-04

Government-NGO Collaboration for Disaster Risk Reduction in India: A SWOT Analysis

J. Parida (1); N. Mishra, (2)
(1) National Institute of Technology, Dept. of Humanities and Social Sciences, Rourkela, Odisha, India; (2) National Institute of Technology, Dept. of humanities and social sciences, Rourkela, India

Effective and meaningful collaboration between the two stakeholders: Government and Non-Governmental Organizations (NGOs) is imperative to attain the goals of Disaster Risk Management (DRM). This is particularly true in all phases of DRM programmes and is very crucial because of their grass-root presence and community-focussed approach. Literature documents GO-NGO partnerships as a constructive forum for improving disaster risk reduction programmes in all phases of DRR programmes. The present study, therefore, focuses on respect and recognition based on four aspects such as cooperation, co-option, complimentary and confrontation (UNESCO, 1989; the World Bank, 1990; Nazam, 1999). Though lots of studies have been carried out on GO-NGO collaboration, but on the aspect of disaster management it is not explored much. Over the last couple of years, a paradigm shift in the approach to disaster management has been carried out by the Government of India. National policies and Acts like Disaster Management Act, 2005; the National Policy on the Voluntary Sector, 2007 and National Policy on Disaster Management, 2009 emphasize the proper coordination of actions of Government and non-Governmental Organizations in a holistic and proactive manner. However, the study is an attempt to identify the Government and Non-Governmental Organizational relationship in various disaster risk reduction programmes particularly at district and panchayat level. To accomplish this objective, this study has attempted to find out the answers of certain questions. GO-NGO collaboration is effective in managing disasters; i) what are the strengths, weaknesses, opportunities and threats (external factors) affecting to achieve the policy-goals of DRR.

In this paper, this study presents results of research undertaken by Asia Risk Centre to assess insurance losses of mNAIS portfolios in India. A crop model is developed using key parameters such as high-resolution gridded weather data, soil types and structure, slope coefficients, irrigation levels and crop-specific growing season parameters. To generate synthetic yields for the last 45 years the model is then driven with historical climate variations. The model parameters are adjusted to reflect the risk potential, especially for systematic events such as droughts, floods and cyclones. Based on the short historical time series, extreme events such as the 1987 or 2002 droughts cannot be effectively captured by statistical methods. Based on these results, yield indices are processed to calculate insurance losses to mNAIS portfolios after consideration of original policy terms and conditions.

This paper reveals how synthetic yields allow a quantitative and robust assessment of i) the profitability levels of a given mNAIS portfolio and growing season and ii) the expected losses from historical extreme events such as the 1987 and 2002 drought events. Synthetic yields of wheat and rice in Uttar Pradesh are compared to historical yields. The results show that the model is able to accurately represent climatically-driven variability in yield. Further, outputs of crop models in general are discussed in terms of benefits for the insurance sector including improved risk assessment, risk pricing, risk transfer and risk management and how simulated weather events can be used in crop models to generate several hundreds of years of synthetic yield series.

P-2233-05

Community based disaster risk reduction practices in Bangladesh

A. Rahman (1)
(1) Khulna university, Urban and Rural Planning, KHULNA, Bangladesh

Bangladesh is one of the most disaster prone countries in the world. In this country, this country has proven superb experienced for disaster risk management as the disaster and relief Ministry of Bangladesh has envisaged long term risk reduction strategy through community involvement institutionalization. The BDRM Committee (2000) bifurcates the policy on Disaster Management, 2009 emphasize the proper coordination of actions of Government and non-Governmental Organizations (nGOs) is imperative to attain the goals of DRM. Over the last couple of years, a paradigm shift in the approach to disaster management has been carried out by the Government of India. Government Organizations and NGOs engaged in disaster management directly or indirectly were interviewed in order to have broader views and opinions on policy matters, problems, opportunities and potentials and to evaluate their roles in that particular area. Open and close-ended questions were used for this purpose. A SWOT analysis was used to focus on the strengths and weaknesses of collaboration in relation to efficiency, capacity building, quality and accountability. The study found that the effective collaboration is lacking between Government and NGOs at local level. Majority of the respondents were not satisfied with the existing mechanism of collaboration in relation to efficiency, capacity building, quality and accountability.

This paper presents results of research undertaken by Asia Risk Centre to assess insurance losses of mNAIS portfolios in India. A crop model is developed using key parameters such as high-resolution gridded weather data, soil types and structure, slope coefficients, irrigation levels and crop-specific growing season parameters. To generate synthetic yields for the last 45 years the model is then driven with historical climate variations. The model parameters are adjusted to reflect the risk potential, especially for systematic events such as droughts, floods and cyclones. Based on the short historical time series, extreme events such as the 1987 or 2002 droughts cannot be effectively captured by statistical methods. Based on these results, yield indices are processed to calculate insurance losses to mNAIS portfolios after consideration of original policy terms and conditions.
in central for planning, implementation and monitoring in the risk reduction interventions which creates community in Early Warning Systems (EWS) which are well recognized as a critical life-saving tool for floods, droughts, storms, bushfires, and other hazards. The National Meteorological and Hydrological Services (NMHSs) who are members of the World Meteorological Organization (WMO) made considerable advances in EWS in the recent years, which are characterized by better observation and monitoring of hazards and improved forecasting and warning services. Also, risk assessment and hazard mapping have been of assistance in development planning and increased the awareness and understanding of risk by the people. However, the societal benefits derived from this progress in EWS have been uneven among countries and communities. Significant gaps remain, especially in servicing the grassroots communities and benefiting poor and vulnerable families.

The global changes in societal structures, rapid urbanization, growing exposure of populations and assets, and climate change, altogether result in a highly dynamic and complex state of disaster risk. This situation, together with the increasing globalisation of risk, calls for strengthened EWS at all levels. It also calls for an integrated and holistic approach to early warnings for multiple hazards and risks tailored to user-needs across sectors. In this regard, international and regional collaboration as well as multi-stakeholder partnerships are critically necessary, given the borderless nature of most natural hazards.

At the Third United Nations World Conference for Disaster Risk Reduction (WCDRR), Member States of the United Nations, through the post-2015 framework for Disaster Risk Reduction (DRR), agreed on the necessity of enhancing multi-hazard early warning systems (MHEWS). In response to this call, the multi-stakeholder partnership – International Network for Multi-Hazard Early Warning Systems – is forged to facilitate and make available to governments and key stakeholders the necessary technical support for strengthening MHEWS as a national strategy towards building disaster and climate resilience. The network embodies the commitment of its partners to act and work together in advancing MHEWS and to foster multi-stakeholder partnership in DRR for promoting societal resilience. A comprehensive description of the International Network and its operational procedures to promote effective disaster risk management are presented.

**P-2233-06**

**Multi-Hazard Early Warning Systems for Effective Disaster Risk Management**

X. Tang (1)
(1) World Meteorological Organization, Weather and Disaster Risk Reduction Service Department, Geneva 2, Switzerland

Every year, disasters related to meteorological, hydrological and climate hazards cause significant loss of life, and set back economic and social development by years. Over the past decade (2005–2014), 3 253 hydrometeorological hazards were reported around the world, resulting in 285 853 externalities and economic losses amounting to US$ 983 million. From 1970 to 2012, storms and floods accounted for 79 per cent of the total number of disasters due to weather, water, and climate extremes and caused 55 per cent of lives lost and 80 per cent of economic losses, while droughts caused 35 per cent of lives lost. Climate change is exacerbating the impact of hydrometeorological hazards and compounding disaster risk. Disaster risk reduction is one of the effective ways of climate change adaptation.

According to the Hyogo Framework for Action (HFA), effective disaster risk management calls for a paradigm shift from emergency response to a more proactive, holistic and systematic approach with strong focus on risk reduction. This paradigm shift requires meteorological, hydrological and climate services to support science-based risk management decisions, as well as investments in Early Warning Systems (EWS) which are well recognized as a critical life-saving tool for floods, droughts, storms, bushfires, and other hazards. The National Meteorological and Hydrological Services (NMHSs) who are members of the World Meteorological Organization (WMO) made considerable advances in EWS in the recent years, which are characterized by better observation and monitoring of hazards and improved forecasting and warning services. Also, risk assessment and hazard mapping have been of assistance in development planning and increased the awareness and understanding of risk by the people. However, the societal benefits derived from this progress in EWS have been uneven among countries and communities. Significant gaps remain, especially in servicing the grassroots communities and benefiting poor and vulnerable families.

The global changes in societal structures, rapid urbanization, growing exposure of populations and assets, and climate change, altogether result in a highly dynamic and complex state of disaster risk. This situation, together with the increasing globalisation of risk, calls for strengthened EWS at all levels. It also calls for an integrated and holistic approach to early warnings for multiple hazards and risks tailored to user-needs across sectors. In this regard, international and regional collaboration as well as multi-stakeholder partnerships are critically necessary, given the borderless nature of most natural hazards.

**P-2233-07**

**Hurricane Sandy and the Prospects for Climate Resilience and Transformative Adaptation in New York’s Jamaica Bay Urban Communities**

S. William (1)
(1) City University of New York – Hunter College, Geography, New York NY, United States of America

Climate change resilience and transformative adaptation requires a greater understanding of how current extreme events influence local and regional development trajectories. Within the New York–New Jersey Metropolitan region, Hurricane Sandy and the immediate response to the storm have created conditions for a potential large-scale transformation with respect to settlement of the coastal zone. While the vulnerability of this region to climate change has been well-documented, Sandy’s impact has placed this issue into the forefront of public and private discussions about the appropriate response at every level from individual homeowners who are contemplating whether and how to rebuild after devastating losses, to small coastal municipalities which are considering construction of protective engineering structures and changes in zoning laws, to the City of New York, the states of New York and New Jersey and the federal government which are engaging in discussions about how to better protect the region’s population, property, and vital infrastructure from future storms. These discussions are particularly complex given that they are now beginning to be discussed within the context of emerging and potentially intensifying climate change.

This paper presents results of a research study that entailed documentation of the initial phases of a transition in coastal communities and neighborhoods in the Jamaica Bay region of New York City that were heavily impacted by Hurricane Sandy. Sandy’s storm surge flooded the region and caused the conditions of stakeholder and community-based organization interviews, we explore: 1) evidence of socio-ecological system stress and crisis; 2) associations between stress and crisis, the resilience of local stakeholders, and shifts in system-level equilibria; and 3) cross-scale connections between stakeholder responses, socio-ecological system transitions, and broader-scale, community level transformations. The reported results are drawn from the conditions of resilience practice and transformative adaptation are highly contested and spatially and societally uneven. This unevenness reveals emerging equity and justice implications within and across the impacted communities.

---

**K-2234-01**

**The Contribution and Centrality of Indigenous Knowledge Systems to Developing Sustainable Adaptation Strategies**

KAS. Kassam (1)
(1) College of Agriculture and Life Sciences, Cornell University, Natural Resources & American Indian Program, Ithaca, NY, United States of America

All over the world, communities that contributed least to the increase in greenhouse gas concentrations are facing their harshest impacts. At the vanguard of climate variation are indigenous communities at high altitudes and latitudes as well as coastal regions. Increasing climate variability
E. Woods (1)
(1) The Royal Society, Science Policy Centre, London, United Kingdom

Extreme weather can have a devastating impact on people’s lives and livelihoods. It represents a major obstacle to development, often preventing people from escaping poverty or pulling them into it. Societies are not well adapted to the extreme weather being experienced today. Compounding this, future climatic and demographic changes will increase the exposure of people and their assets to this threat.

In this presentation, Professor Georgina Mace CBE FR S will outline the findings of the Royal Society’s ‘Resilience to extreme weather’ report (see royalsociety.org/resilience). The culmination of 18 months’ evidence gathering and analysis, this policy report examines not only the risks posed by extreme weather, both now and in the future, but also the range of ways in which people can adapt and become more resilient to these risks.

Resilience-building solutions range from specific physical defences (ecosystem-based approaches, engineered approaches, and hybrids of the two) to more general principles and processes for building resilience globally, nationally and locally.

The use of scientific evidence to inform which solutions are most appropriate in which circumstances is crucial. In the context of this year’s international agreements on disasters (March), sustainable development (September) and climate change (December), ensuring that efforts to build resilience are joined-up across different policy frameworks is also important.

Climate Change Resilience and Vulnerability Analysis of Indigenous Community in Western Himalaya

BW. Pandey (1)
(1) University of Delhi, Department of Geography, Delhi, India

Present research is an attempt to investigate the impact of microclimate change on agro horticultural crops, water supply and vulnerability of livelihood security among the local community in Upper Beas Basin of Western Himalaya. Study is based on both the Primary as well as Secondary sources of data. To collect the primary data, twenty two hamlets of the Valley between the elevations of 2000-3000 meters were surveyed on the basis of Stratified Random Sampling (SRS). Two hundred questionnaires were fulfilled along with the physical investigations of quality and quantity water and land use changes between 1954 to 2014. Attempt has been made to assess the changes in food availability, quality and quantity measurement and analysis of changes in method and mode of food supply. At the end, effort has been made to analyse future vulnerability and changes in the nature of occupations and household economy due to local climate change.

The research findings highlight that the number of livestock has been increased in the valley, while the areas under grazing land has been reduced. This is because of the privatization of the land and closing the forest area. Consequently more pressure has been exerted on agricultural land. The number of households of the nomadic herders has decreased, as their efforts to build resilience have proven less successful and future generation is migrating towards plain for job in metropolitan areas like Delhi and Mumbai. Agricultural practices have been shifted upwards 400 meter to 1000 meter between 1954–2014. Another finding highlights that there were less than 10 hotels in Manali in 1975, which has increased to more than 1500 in 2014. Land Use Land Cover Changes, Urbanization and vehicular pollutions are the principal factors for local climate change. Growth of
Tourism based urbanization has taken place on agrarian land in the Himalayan geosystem is economically lucrative today, but can pose a risk of food crisis tomorrow as non-agricultural uses of the land is increasing in the interest of the outside population on the cost of the local farmers. A planned land use from the government is necessary to save the livelihood security and vulnerability of food supply to the local community of the Western Himalaya.

P-2234-02

Public policies and risk management in extreme hydrological events in Southeast Mexico

F. Tudela (1); M. Vicarelli (1); A. Aguilar (2)
(1) University of Massachusetts, Economics department, Amherst, United States of America; (2) ITAM, Economics department, Mexico City, Mexico

Extreme hydrological events have already jeopardized development in Southeast Mexico. Their economic impacts have been regularly assessed and exceed by far any other socio-economic aspect. A clear example may be found in the floods that affected the State of Tabasco in October–December 2007, when nearly one million inhabitants -more than half the State’s population- was severely affected, and 80% of Villahermosa, the capital city, was underwater. Attribution issues– natural variability / climate change impacts -remains uncertain but some statistical data, some of them included in this presentation, point at the increasing relevance of anthropogenic factors. The already vulnerability of socio-environmental systems has been aggravated, but the hazards themselves are apparently gathering momentum. Current public policies dealing with risk management are considered now inadequate, and will be even more defective as climate change progresses.

This contribution focuses on these policies, which neglect an integral approach to prevention and adaptation approaches. It includes a comparison between the expenditures from FONDEN (Fondo de Desastres Naturales) and those from FOPREDEN (Fondo para la prevención de desastres naturales). Land use planning tools are also questioned in terms of their effectiveness. An in-depth revision of the risk management policies, that should pave the way for new systemic approaches, will be spurred by an increasing recognition of climate change progresses.

By undertaking a cost-benefit analysis, the effectiveness of the strategies was assessed, and a prioritization of the most adequate ones for each scenario was done.

The non-structural strategies presented higher net benefits than the structural ones, due to their low cost. However, the structural strategies could better cope with flood impacts, but at higher costs. Nevertheless, the economic benefits of these strategies were only related to the Raval District. By extending the domain analysed, the results would be different.

References


P-2234-03

Cost-benefit analysis of flood resilience strategies to cope with global change impacts. Application to the Barcelona case

M. Velasco (1); R. Beniamino (2); A. Cabello (3)
(1) CETAqua, Global Change Impact Programme, Cornellà de Llobregat, Spain; (2) Aqualogy, Urban drainage direction, Barcelona, Spain; (3) CETAqua, Sustainability department, Cornellà, Barcelona, Spain

Urban areas are, due to the concentration of population and economic activities, one of the most sensitive regions to natural hazards. This work presents the results of a flood damage assessment taking into account the effects of different socio-economic and natural changes. This work is part of the FP7 CORFU project (Collaborative Research on Flood Resilience in Urban areas) focusing in the Raval district of Barcelona.

The first stage of this work consisted on creating a detailed flood damage assessment for the case study area. The implementation of a new 1D–2D coupled model was used to obtain flood depths (Russo et al., 2014), and new stage damage curves were developed to estimate the direct tangible damages (Velasco et al., 2015a). The curves were validated using data from surveys and actual reported damages to the Spanish re-assurance. Then, combining the hazard and vulnerability levels by using a GIS-based toolbox, the expected annual damages (EAD) of the area was obtained. This enables the determination of the critical points of flooding in impacts, and highlights the need to implement strategies to cope with these impacts.

For a time horizon centered in the year 2050, several future scenarios of climate and socio-economic changes were created. Using the previously developed tools, the EAD values of the several future scenarios were obtained for the Raval District (Velasco et al., 2015b). The comparison between future and current damages presented increase ratios that ranged between 1.5 and 4. This highlighted the need for implementing adaptation strategies to cope with possible future impacts.

Finally, different measures were modelled so the corresponding damages could be calculated. Three different levels of adaptive capacity were studied:

• Low: measures implemented should be non-structural, and only focusing on vulnerability and risk reduction. In this case, local protection measures (flood board) linked to an early warning system were analysed
• Medium: it consists of SUDS (Sustainable Urban Drainage Systems), and specifically green roofs
• High: it considers classical structural measures, which were 6 new pipes upstream the Raval district, and one storage tank in this area

By undertaking a cost-benefit analysis, the effectiveness of the strategies was assessed, and a prioritization of the most adequate ones for each scenario was done.

The non-structural strategies presented higher net benefits than the structural ones, due to their low cost. However, the structural strategies could better cope with flood impacts, but at higher costs. Nevertheless, the economic benefits of these strategies were only related to the Raval District. By extending the domain analysed, the results would be different.

Medium-term effects of early-life weather shocks on cognitive and health outcomes

M. Vicarelli (1); A. Aguilar (2)
(1) University of Massachusetts, Economics department, Amherst, United States of America; (2) ITAM, Economics department, Mexico City, Mexico

This paper investigates medium-term consequences of negative weather extremes experienced during early stages of life on children’s physical and cognitive development. In rural, rain-fed agricultural settings, rainfall shocks are often cited as the most important risk factor faced by households (Prosgresa–Mexico 1998–99; Fafchamps et al. 1998; Gine, Townsend-Peter and Viollier 2005) Young children and pregnant women represent particularly sensitive populations to events of this nature.

The idea that stimuli or stressful conditions during critical periods in early life can have lifetime consequences is well established in developmental biology (Barker 1998). Previous work in the economics literature has also shown how pervasive conditions (e.g. malnutrition, sickness, pollution, etc.) in utero and during the first years of life have considerable long-term consequences. Some of these studies identify effects of early life conditions on outcomes such as income, health, educational attainment, and physical and mental disabilities (Alderman et. al. 2003; Almond 2006; Almond and Mazumder 2011; Maccini and Yang 2009). In this study we shed light on medium term impacts: test scores for language development, working and long-term memory, and visual–spatial thinking provide information about specific dimensions of cognitive development. This information, added to objective anthropometric measures (like height and weight) and gross motor skills, has been
ABSTRACT BOOK

Early warning systems for climate related extreme events: The development of an ICT based multi-hazard and multi-sector early warning platform in Kenya

E. Vogel (1); A. Kooiman (2); Z. Zommers (3)
(1) University of Melbourne, School of earth sciences, Melbourne, Australia; (2) Geo Enviagro Solutions International, Nairobi, Kenya; (3) United Nations Environment Programme, Division of early warning and assessment, Nairobi, Kenya

The Fifth IPCC Assessment Report on climate change shows that the frequency and/or intensity of different types of weather extreme events is likely to increase in a number of regions across the globe. Additional pressures on socio-economic and environmental systems due to population growth, rapid urbanization, conflicts and environmental degradation, particularly in developing countries, are likely to further increase the vulnerability of populations and to exacerbate the risks of severe impacts from climate hazards. Early Warning Systems (EWS) form an important part of national disaster risk management (DRM) strategies and are important to protect communities against the immediate threat and consequences of climate-related extreme events.

However, although great efforts have been made to improve EWS worldwide, many of the existing systems have important shortcomings: Often, EWS focus on one hazard type only, ignoring interactions between concurrent hazards. There are also important climate impacts in a standardized way and taking into account all sectors that are vital to the functioning of societies and relationships between sectors. Furthermore, the communication of warnings is not always adequate, either by not reaching affected populations or by not providing timely and reliable warning. Finally, in many cases early warnings are not sufficiently linked to rapid response measures.

The aim of the United Nations Environment Programme’s CLIM-WARN project was to review the current status of multi–hazard Early Warning Systems in three African countries (Kenya, Ghana and Burkina Faso), to identify capacity gaps, to assess the needs of vulnerable communities, to review best practices for early warning communication and response and to develop a set of recommendations for decision makers to improve existing Early Warning Systems which are applicable between the case study countries. An important gap that was identified by stakeholders is the lack of a central platform which integrates hazard warnings from relevant national agencies and provides a visual interface for accessing hazard risk data and which facilitates the communication of warnings to vulnerable groups. These findings resulted in the development of a prototype platform which integrates hazard warnings from relevant national agencies and provides a visual interface for accessing hazard risk data and which facilitates the communication of warnings to vulnerable groups.

This talk will present the methodological framework which underpins the development of this prototype platform and demonstrates how it provides a visual interface for accessing hazard risk data from different data sources, automatically calculates hazard impacts and disseminates subscription-based warnings and response recommendations to users, based on their data needs and preferred communication channels.

The combination of multiple forecasting datasets in one platform has several benefits: It ensures a comprehensive assessment of impacts in all major sectors, taking into account relationships between hazards and sectors; it facilitates the creation of integrated response plans and the exchange of data and knowledge between different stakeholders. Furthermore, it enhances the visibility of risk and hazard data and by this, helps to raise awareness. Remaining gaps and challenges are related to data availability and knowledge between different stakeholders. Furthermore, it enhances the visibility of risk and hazard data and by this, helps to raise awareness.

The combination of multiple forecasting datasets in one platform has several benefits: It ensures a comprehensive assessment of impacts in all major sectors, taking into account relationships between hazards and sectors; it facilitates the creation of integrated response plans and the exchange of data and knowledge between different stakeholders. Furthermore, it enhances the visibility of risk and hazard data and by this, helps to raise awareness. Remaining gaps and challenges are related to data availability and knowledge between different stakeholders. Furthermore, it enhances the visibility of risk and hazard data and by this, helps to raise awareness.

ORAL PRESENTATIONS

O-2235-01

Tree-based energy for resilient livelihoods and ecosystems under climate change in Kenya

M. Njenga (1)
(1) ICRAF, Nairobi, Kenya

Kenya has a population of 39 million people with 68% of the population living in rural areas and half of her population lives below poverty line. Kenya has a land area of 580,726km2 of which approximately 85% is arid and semi-arid land (ASAL) and support 30% of the population and 70% of the livestock production. Africa’s backbone of the Kenyan economy directly contributing 24% of the GDP valued at KSh342 billion in 2009 and another 27% indirectly, valued at KSh385 billion. The country is experiencing the climate change effects as prolonged droughts, frost in some of the productive agricultural areas, hailstorms, extreme flooding, receding lake levels, drying of rivers and other wetlands, leading to economic losses and environmental degradation. For instance the floods of 1997/98 affected 1 million people

P-2234-05

Early warning systems for climate related extreme events: The development of an ICT based multi-hazard and multi-sector early warning platform in Kenya

E. Vogel (1); A. Kooiman (2); Z. Zommers (3)
(1) University of Melbourne, School of earth sciences, Melbourne, Australia; (2) Geo Enviagro Solutions International, Nairobi, Kenya; (3) United Nations Environment Programme, Division of early warning and assessment, Nairobi, Kenya

Climate experts indicate that ENSO cycles will continue to affect global climate, and events might become more frequent and intense with global warming (Vecchi and Wittenberg 2009). ENSO-related studies are therefore relevant from an economic, climatic, and public policy perspective. To the authors’ knowledge this is the first study to investigate the impact of ENSO-related weather shocks on human development. More broadly, this study represents an important test bed to further understand the possible impacts of weather extremes associated to climate change on human capital development (i.e. child cognitive and physical development). This type of impacts is still vastly underestimated in the economics literature.

Proven as a strong predictor of success later in adulthood (Case and Paxson 2006, Grantham–McGregor et al. 2007), early childhood conditions in early child development (in utero and up to two years of age), the socio-economic and health data in this study come from a rich longitudinal household dataset gathered as part of Mexico’s PROGRESA randomized poverty alleviation program. This database is exceptional for size and data quality and data includes valuable information for children aged 2 to 6, namely, specific indicators of cognitive development, motor skills, as well as objective anthropometric and health indicators.

Our analysis shows that, for four to five years after the shock, children exposed to floods in early life have test scores in language development, working-memory, and visual–spatial thinking abilities that are 11 to 21 percent lower than same aged children not exposed to the shock. Negative effects are also found on anthropometric characteristics: children exposed in early life exhibit lower height (1.07 to 1.80 cm), higher likelihood of stunting (11 to 14 percentage points), and lower weight (0.381 kg) than same aged children not exposed to the shock. Negative effects of weather shocks on income, food consumption, and diet composition during early childhood appear to be key mechanisms behind the impacts on children’s outcomes. Finally, no mitigation effects were found from the provision of the Mexican conditional cash transfer program Progreso on poverty outcomes for children exposed to ENSO-related shocks. This might suggest that children were not prioritized in distributing resources within the household or that the cash transfer was not sufficient to buffer the liquidity constraint faced by the household and generated by the weather extreme.

The combination of multiple forecasting datasets in one platform has several benefits: It ensures a comprehensive assessment of impacts in all major sectors, taking into account relationships between hazards and sectors; it facilitates the creation of integrated response plans and the exchange of data and knowledge between different stakeholders. Furthermore, it enhances the visibility of risk and hazard data and by this, helps to raise awareness. Remaining gaps and challenges are related to data availability and knowledge between different stakeholders. Furthermore, it enhances the visibility of risk and hazard data and by this, helps to raise awareness.

The combination of multiple forecasting datasets in one platform has several benefits: It ensures a comprehensive assessment of impacts in all major sectors, taking into account relationships between hazards and sectors; it facilitates the creation of integrated response plans and the exchange of data and knowledge between different stakeholders. Furthermore, it enhances the visibility of risk and hazard data and by this, helps to raise awareness. Remaining gaps and challenges are related to data availability and knowledge between different stakeholders. Furthermore, it enhances the visibility of risk and hazard data and by this, helps to raise awareness.
and cost the economy US$ 0.8–1.2 billion.

Trees provide various ecosystem services that build resilient social–ecological systems through (i) providing biological products such as fruit, browse for livestock, medicines for human and livestock, oils, construction materials, woodfuel and gums and resins, (ii) supporting services of soil fertility management, soil moisture and biodiversity, (iii) regulating services on macro and micro climate, (iv) watershed management, and (v) cultural services. The loss of trees under climate change is of great concern to the country which has retained only 2% forest cover.

One of the drivers of tree loss is the unsustainable woodfuel sector. Over 80% of households in rural areas and 70% of households nationally depend on firewood. Charcoal ranks second as a source of cooking energy in Kenya and is used by 82% of urban and 34% of rural households; and most of it comes from the drylands. Trees on–farm provides carbon energy through saving wood and grain, and time and drudgery in traveling long distances in search of firewood and reduces household expenditure. Recycling organic by-products into briquettes generate income and employment for women and youth and the product burns cleaner and longer. Improved cook stoves generate income from sales of stove, save fuel and time, reduce emissions and some produce charcoal by–product. As such scaling– up of the following local innovations will reinforce resilience of livelihoods and ecosystems through tree–based energy; (i) wood energy production through short rotational forestry, farmer managed natural regeneration, coppice management, intercropping trees with crops or pasture, (ii) briquetting agricultural, tree and municipal organic by–products, (iii) improved cooking technologies (iv) large–scale gasification of biomass, for instance of invasive tree/shrub species, wood, crop and pasture residues, and (v) by–product – charcoal dust and (v) policy framework that supports and creates awareness on growing of trees for energy and resilient livelihoods and ecosystems and regulate tree–based energy trade.

O-2235-02

A Community based initiative of afforestation for charcoal production: Case study Siaya County, Kenya

N. Oduor (1) ; J. Maua, (2)

(1) Kenya Forestry Research Institute, Forest Products Research Centre, Nairobi , Kenya; (2) Kenya Forestry Research Institute, Kakamega sub–centre, Kakamega, Kenya

It is estimated in Kenya that about 90% of rural households use fuelwood either as firewood or charcoal with firewood meeting the energy needs of over 93% of rural household, and charcoal being the dominant fuel in urban households. Besides being the most common cooking fuel for the majority of Kenyan households, fuelwood is also an important energy source for small–scale rural industries such as charcoal production, brick making, tea drying, brick making, fish smoking, and bakeries, amongst others. The principal sources of fuelwood are agro–forestry (84%), biomass in trust lands (8%) and gazetted forests (8%). Kenya is a relatively dry country, with approximately 80% of total land area defined as arid and semi–arid. The current status of much dry land forest resources is the direct result of wasteful practices and degradation, from overgrazing, overexploitation of trees for the acquisition of firewood and charcoal particularly in the close vicinity of towns and refugee camps.

Currently, there is a growing imbalance between supply and demand of biomass energy. In 2012, the firewood and charcoal demand stood at 18,702,748m³ and 7,358,717m³. The total biomass estimation based on diameter and height was calculated as Y = 0.0006x where x is (dbh2 * ht), r2 = 0.94. The optimum age for charcoaling was determined by charcoaling the two Acacia species aged 4 and 6 years old. The optimal tree spacing (where it allowed selective harvesting - not clear felling) was 2.5m X 2.5m. The total biomass energy production through diameter and height calculation was 2.5m X 2.5m, 3m X 3m up to 4m X 2m and 4.5m X 1m were set up. Three efficient charcoal kilns were used (half orange kiln, drum kiln and Casamance kiln) and lastly the optimal age for charcoaling was determined by charcoaling the two Acacia species aged 4 and 6 years old.

The current estimated area of land under acacia is 240 hectares with an estimated yield of 100 tons of round wood or 30 tons of charcoal per hectare under six years rotation. The number of farmers who have set aside land sizes ranging from 0.5 – 3 acres (0.21 – 1.25 Ha) for wood lots, now stand at 545.

O-2235-03

Are we ready to scale-out climate-smart agriculture in South Asia?

P. Aggarwal (1); K.C. Arun (1); B. Paresh (1); M. Jat (2); P. Thornton (3); A. Jarvis (3)

(1) CCAFS, IWMI, New Delhi, India; (2) CIMMYT, New Delhi, India; (3) ILRI, Nairobi, Kenya; (4) CIAT, Cali, Colombia

Recent IPCC report and several other studies indicate a probability of 10–40% loss in crop production in India and other countries of South Asia with increases in temperature by 2070–2100 and decrease in irrigation water unless steps are started now to increase our adaptive capacity. There could be significant losses on some crops such as wheat even in short–term. Droughts, floods, tropical cyclones, heavy precipitation events, hot extremes, and heat waves are known to negatively impact agricultural production, and farmers, whose livelihoods are dependent on agriculture, are the most vulnerable to these events. The projected increase in these events will result in greater instability in food production and threaten livelihood security of farmers. Increased production variability could be perhaps the most significant impact of global climate change. Signs of decrease in yields due to changing weather have started becoming visible.

Several technological, institutional and policy interventions have been proposed that can help us adapt to climate change as well as to current and future weather variability. These include, simple, low–cost interventions such as change in planting dates and crop varieties. Additional strategies for increasing our adaptive capacity include bridging yield gaps to augment production, deployment of adverse climate tolerant genotypes and diversified land use systems, the use of solar irrigation, assisting farmers in coping with current climatic risks through providing weather linked value–added advisory services to farmers and crop/weather insurance, and improved land and water use management and policies. It is interesting to note that most of the proposed adaptation options, if implemented scientifically, can come with large mitigation co–benefits.

CCAFS is scaling out the Climate–Smart Villages (CSVs) model in several countries, including in South Asia, to promote climate–smart agriculture (CSA). Climate Smart Villages are sites of work with smallholder farmers that integrate technological and institutional interventions, determined by the local community, are implemented to increase food production, enhance adaptive capacity and reduce emissions. Interventions are bespoke to each village but the concept lends itself to be applied in any region under the right circumstances. Initial results suggest a large potential to maximize synergies among different interventions in order to scale out CSA.

While most of these interventions have indeed shown increased production potential and even mitigation, their scale–up coverage is still small. This paper argues that evidence base for many of these interventions is still limited and we need enough context specific targeted knowledge about them before they can be applied on a large scale. In addition, lack of appropriate business models around
The impact of bioenergy development on the climate resilience of vulnerable communities in Kenya

S. Abrar (1)

(1) Edinburgh University, Edinburgh, United Kingdom

The purpose of this project is to examine whether bioenergy developments have an impact on the climate resilience of vulnerable communities in Kenya. Interviews were conducted with professionals and several projects and programmes were visited on site. The research, based on evidence, shows that traditional use of solid biomass, which is the most popular source of energy in Kenya, is believed to have a negative impact on climate resilience. However, most of the interviews and projects visited have also demonstrated that, in certain conditions and under specific circumstances, bioenergy developments can reveal strong climate resilience characteristics. If they cannot by themselves improve considerably the resilience to climate change, some of them, when combined with measures and initiatives aimed at improving the life of the most vulnerable, do achieve this purpose. This study also demonstrates, once again, how important it is for any project, programme or technology to address the specific needs and priorities of the populations they intend to serve and how engagement, empowerment and ownership by the communities is key to achieve success. A higher consideration and respect for local cultures and ways of living, promoting a grass-roots approach, encouraging collective actions through capacity building and awareness raising, and finally providing financial and political support, will help generate more suitable and targeted technologies and programmes, including those related to bioenergy, that would improve the climate resilience of vulnerable communities in Kenya and elsewhere.

Multiple benefits of biochar: Synergism or trade-offs

E. Yeboah (1)

(1) CSIR–Soil Research Institute, Microbiology, Kumasi, Ghana

Poor soil fertility is a key constraint to improving farm productivity and farmer livelihoods in sub-Saharan Africa. The search for sustainable soil management practices is still on. Biochar, a pyrolysed biomass in recent years has gained international recognition to improve soil productivity and farmer livelihoods. However, limited research on biochar in Ghana to warrant government policy. A field study was conducted in the major season of 2012 in the semi-deciduous forest zone and the Guinea savanna agroecological zones of Ghana. The objective was to determine soil management scenarios that will enhance the beneficial effect of biochar application to soils. The treatment were compost, biochar at 2 t/ha and 4 t/ha biochar. Each main treatment received 0, 30, 60 and 90 KgN/ha. The test crop was maize. 4 t/ha biochar + 90kg N/ha increased maize yield indices across sites. Biochar increased N use efficiency and improved gravimetric soil moisture contents across sites. The synergistic effect rather than trade-offs of the biochar technology to address energy use of the smallholder farmer through the use of efficient cookstoves, the bio-physical constraints in the context of soil improvements to increase food security, soil carbon sequestration for climate change mitigation as well as the socio-economic constraints in the context of soil improve

Moving from climate vulnerability to Resilience: a case study of Bangladesh

S. Huq (1)

(1) International Center for Climate Change and Development (ICCCAD), Dhaka, Bangladesh

Bangladesh has been identified well over a decade ago as being one of the most vulnerable countries to the potential adverse impacts of human induced climate change. Over the last decade the country has been one of the first of the Least developed Countries (LDCs) to carry out their National Adaptation Programme of Action (NAPA) as mandated by the United Nations Framework Convention on Climate Change (UNFCCC) as it’s 7th Conference of Parties (COP7) held in Marrakech, Morocco in 2001 under the Marrakech Accords, which provided technical assistance and financial support to the LDCs for carrying out the NAPAs.

Subsequently the Government of Bangladesh built on the NAPA which was only meant to identify urgent and immediate adaptation actions, to develop a more elaborate and longer-term Bangladesh Climate Change Strategy and Action Plan (BCCSAP) which has six pillars and forty actions. These actions have been funded by creating two Climate Change funds, one with the Government of Bangladesh’s own fines and the other with donors contributions. Both the funds together have now funded over three hundred projects to tackle climate Change. While most of them are adaptation related a few are also mitigation. Related as mitigation was one of the six pillars of the BCCSAP.

Thus over the last decade Bangladesh, including the government as well as other stakeholders such as civil society, universities, media and private sector have already invested in various activities to tackle climate Change and a result have come up with a plan that enhances the collective understanding of what is needed. The latest development in this journey of tackling the adverse impacts of climate Change is to focus on Resilience as opposed to Vulnerability. Bangladesh has now been on identifying vulnerability and helping to build adaptive capacity it has now moved to identifying underlying characteristics of resilience and building on those strengths rather than focus on vulnerability and only invest on risk management alone. This is also in many ways a transition from investing in incremental adaptation to transformational adaptation using the climate change challenge as opportunity.
of technical, economic/financial, and institutional dimensions. When faced with a threat such as drought or flooding, the first instinct is to invest in hardware such as dams to capture and store water for dry periods, or sea-walls to protect from floodwater. And such tangible infrastructure is clearly important. But alongside such investment in the physical hardware of protection, there are a range of vital intangible investments needed in the software of institutions for managing variable resources, and in how communities adapt to a new steady-state (e.g. associated with return to their initial state after disturbance, but will rather adapt to a new steady-state (e.g. associated with return to their initial state after disturbance, but will rather adapt to this systems approach, and the role that different actors need to play.

2235-POSTER PRESENTATIONS

P-2235-01

Adaptive Resilience as an integrative concept for understanding and managing the response of ecosystems to multiple disturbances and changes

WL. Kutsch (1); E. Falge (2); C. Brümmer, (2); R. Scholes (3); C. Schmullius, (4); T. Thiel-Clemen (5); W. Twine, (6); G. Midgley, (7)

(1) 10 Integrated Carbon Observation System (ICOS RI), Head Office, Helsinki, Finland; (2) Thünen Institute for Climate Smart Agriculture, Braunschweig, Germany; (3) University of Witwatersrand, Johannesburg, South Africa; (4) Friedrich Alexander University, Erlangen, Germany; (5) University of Applied Sciences, Hamburg, Germany; (6) University of Witwatersrand, Johannesburg, South Africa; (7) Stellenbosch University, Stellenbosch, South Africa

Nowadays, many ecosystems are affected by multiple kinds of disturbances and changes on different time scales: one might be the strong disturbance by land use (e.g. harvest of the woody biomass in forests, grazing) or land use change (mainly conversion to agricultural land); the second, slower and more a change than a disturbance is climate change, caused by rising concentrations of greenhouse gases in the atmosphere (Higgins et al. 2010). Climate change results in a variety of changes in temperature and precipitation patterns, but also higher probability of extreme weather events. These changes may massively influence hydrochemical cycles as well as the balance between species.

Based on this, it can be hypothesized that many ecosystems, even if they are very resilient, may not return to their initial state after disturbance, but will rather adapt to a new steady-state (e.g. associated with the intermediate change in climate). We can name this phenomenon “Adaptive Resilience of Ecosystems”. It can be used as a further development of classical resilience concept and use it as base for integrative research and management concepts. This is outlined with the example of semi-arid savanna ecosystems.

P-2235-02

Climate vulnerability of the supply chain: methodological review

A. Miola (1); A. Valeria (2)

(1) EU Joint Research Center Institute for Environment and Sustainability, Climate risk management unit, Ispra, Italy; (2) Liverpool Hope University, Business school, Liverpool, United Kingdom

The increasing complexity of the present economic system and the strong interdependencies existing between production activities taking place in different world areas make modern societies vulnerable to crises. The global supply-chain is a paradigmatic example of economic structures in which the impacts of unexpected events propagate rapidly through the system. Climate change, which affects societies all over the world, is one of the most important factors influencing the efficiency of the present economic networks. During the last decades a large set of studies have been oriented to investigate the direct impacts generated on specific geographical areas or productions. However, a smaller number of analyses have been oriented to quantify the cascading economic effects generated all over the world. The great complexity of the global economic system, coupled with methodological and data gaps makes it difficult to attribute the possible consequences to specific causes. Within this context, the main objective of the present report is to provide an overview of the main studies, methodologies and databases used to investigate the climate vulnerability of the global supply chain. The information can be useful to i) support further studies, ii) to build consistent methodological approaches, and iii) to fill the possible data gap.

P-2235-03

Testing and Piloting Climate Smart technologies in Pastoral and Agro Pastoral systems: The case of Ijara sub-county, Garissa County in Kenya

E. Okiri (1); M. Okoti (2)

(1) Kenya Agricultural Livestock Research Organization, Environment and Climate Change, NAIROBI, Kenya; (2) Kenya Agricultural and Livestock Research Organization, Environment and Climate Change Research, Nairobi, Kenya

Ijara is one of the six sub-counties that form the Garissa County in North-Eastern Kenya; it falls into agro-ecological zone V-VI; temperatures range from 15-36ºC and rainfall is between 700-1,000 mm per annum. The average relative humidity is 68%. The sub-county covers an area of 10,000 km², with more than 90% of the land as trust land. The population within the sub-county was estimated at 100,000 during the 2009 national population census, with a population growth rate of 3.7%, while the poverty index stood at 63% with over 80% of households depending on pastoralism. The main economic livelihood of the inhabitants of Garissa County is livestock keeping. The pastoral households face a number of challenges that constrain their ability to employ productive investments in land and livestock in order to counter the expected climate change. These include, amongst others, increased rainfall variability, extreme temperature changes, which has led to environmental degradation such as loss of biodiversity and soil erosion. Climate change is also a driver of poor resource management, as people resort to unsustainable land-use practices such as over-grazing, continued expansion of croplands, increased use of charcoal production to manage recurrent shocks to their livelihoods. To deal with challenges affecting major livelihoods in the county and to reinforce the resilience of the community, the Kenya Agricultural Livestock Research Organization (KALRO) and International Development Research Centre (IDRC) project used various approaches including reconnaissance surveys; Risk and Vulnerability Assessment, including downscaling of climate information; and participatory identification of viable adaptation options. These adaptation options were piloted through farmer field schools. The project also organized field days and exchange visits in productive landscapes, livestock management as part of stakeholder capacity building, with a mix of adaptation options to establish pastures at the individual farm level. The downscaled climate information indicates that Ijara sub-county is getting warmer. This coupled with increased climate variability implies that planning for appropriate adaptation options is mandatory. In order to counter the expected loss of livestock and crops, the sub-county has a mix of adaptation options needs to be put in place in the sub-county. A key option is the establishment of pastures at the individual farm level. Results from the project’s fodder coordination showed that the establishment of rain-fed Sudan grass is feasible as both a short-term and a long-term adaptation strategy. The grass is highly adaptable in the region and gave an average yield of 24 tonnes/ hectare/year. This can support up to 16 milking cows per year, and so can contribute greatly to food security at the household level. The benefit-cost ratio was 1.25. Socio-cultural and economic changes has negatively affected the traditional livestock management practices e.g. breeding techniques.
management. After a series of capacity building initiatives, households started putting in place measures to improve their livestock herd. These included selecting of breeding males and females; castration of excess males; avoiding the use of polled bucks; culling of one testicle males; taking care in the administration of drugs; adoption of camels as opposed to cattle – it was a cultural taboo for them to keep camels despite camels’ better resilience to climatic shocks compared to cattle. Study/exposure tours had a strong positive influence on agricultural technology adoption among pastoralists. From the project initiatives, the farmers’ ability to perceive climate change and related climate variability was a key precondition for their choice to invest in fodder production and conservation. Demonstration and information allowed the households, and also policy makers, to make rational decisions on investment options.

P-2235-04

Three decades of changes in stream communities of France reveal ecosystem shifts and resilience mechanisms in temperate region freshwater ecosystems

K. Van Looy (1) ; M. Floury (1) ; M. Ferréol (1) ; J. Piffady, (1) ; Y. Souchon, (1)

(1) Irstea Lyon, Milieux Aquatiques Lyon, labo hydroécologie quantitative MALY, LHQ, Lyon–Villeurbanne, France

Global warming is assumed to be a threat to temperate stream biodiversity. Still, many of the processes and mechanisms behind the predicted threats to diversity remain uncertain. We identified current trends and drivers of change for freshwater communities over a large spatial and temporal scale already revealing a strong ecosystem shift.

We analysed diversity and composition shifts in stream invertebrates communities during the last three decades in relation to environmental and human stressors that we observed a 42% increase in the taxonomic richness of stream invertebrates communities, largely caused by climate change (23% purely climate-induced taxonomic richness increase). As a local mechanism, a bottom–up food web productivity response to rising temperature was responsible for this strong increase in diversity. Stochastic assembly processes (both environmental stochasticity and dispersal related stochasticity) increased the regional scale diversity, giving spatial insurance to biodiversity and lowering the risks of biotic homogenisation.

Thus, stream invertebrate communities show strong resilience to environmental changes thanks to local and regional responses of productivity changes (resource resilience), and thanks to landscape heterogeneity (refugia resilience) and dispersal processes (recruitment resilience). For the French streams, resilience mechanisms now seem to outweigh the predicted threats. From this knowledge emerge scenarios that enhance the temorary streams’ resilience to cope with further global changes.

O-2236-01

Building and analyzing large numbers of socio-economic scenarios for decision support under uncertainty: a modelling experiment to explore the main determinants of economic growth in a carbon-constrained world

C. Guivarch (1) ; J. Rozenberg (2)

(1) Centre International de Recherche sur l’Environnement et le Développement (CIRED), Paris, France; (2) World Bank, Climate Change Group Chief Economist Office, Washington DC, United States of America

Climate change poses a challenge to traditional decision making techniques due to long time scales, complex systems that couple human, technical and natural elements, and multiple uncertainties. Scenario technique is a key tool for decision making in such context. Here we demonstrate how building and analyzing databases of scenarios that explore the “uncertainty space” can bring novel insights for decision support. We do so in an illustrative study that focuses on identifying the main sources of technological and socio-economic uncertainty for indicators used for policy decision.

The relevant measure for the macroeconomic evaluation of mitigation pathways depends on the question at stake: deciding on the level of mitigation to target or choosing a strategy to meet an already fixed target. Choosing the level of greenhouse gases emissions reduction to target requires balancing mitigation costs against avoided costs from climate change damage. Both costs are usually measured by GDP or welfare losses compared to a baseline – a scenario with no mitigation and no damage. However, whether this balance is affected by climate change is being increasingly called into question, in particular because estimates of the damage that can be caused by climate change are highly uncertain and probably in the realm of megadollars. Whether the stabilization target is already fixed, the design of the best strategy is better informed by absolute levels of GDP in pathways that meet the target.

We construct a modelling experiment to explore the role of a wide range of socio–economic uncertainties for the two metrics: absolute per capita GDP under mitigation scenarios and GDP losses with respect to the baseline. The modelling experiment takes the form of an analysis
of an ensemble of 648 scenarios, built with an Integrated Assessment Model that represents the intertwined evolution of technical systems, energy demand behavior and economic growth. The model parameters are grouped into six parameter sets: productivity growth in the leading country, productivity catch-up in other countries, energy demand behavior, end-use energy efficiency, availability of low-carbon technologies, and availability of unconventional fossil fuels. Combining alternative assumptions on the values of the parameter sets leads to 216 baselines. For each baseline, two mitigation scenarios are modeled. Both meet an exogenous emissions trajectory constraint leading to a 50% reduction in global emissions by 2050 compared to 2000. They differ in the use of the carbon tax revenues – revenues are either redistributed to households or used to reduce pre-existing taxes.

In the resulting ensemble of mitigation scenarios, we find that GDP losses and absolute GDP are not well correlated and are not determined by the same (uncertain) drivers. We identify the most important sources of uncertainty for absolute GDP in mitigation scenarios and for GDP losses with respect to the baseline, using a regression tree algorithm. We find that GDP losses against baselines are mainly determined by the design of the climate policy and the availability of low-carbon technologies whereas absolute GDP in mitigation scenarios is mainly determined by end-use energy efficiency and energy demand behavior. More generally, our modeling experiment shows that in the context of comparative GDP, GDP losses and absolute GDP are not well correlated and do not give the same insights for policy designs. Realizing the difference is important to focus on the relevant information for each type of decision.

Despite, and because of, the uncertainty surrounding future damage caused by climate change, decision-makers should to devote more attention to GDP losses against baselines and the availability of low-carbon technologies whereas absolute GDP in mitigation scenarios is mainly determined by end-use energy efficiency and energy demand behavior. More generally, our modeling experiment shows that in the context of comparative GDP, GDP losses and absolute GDP are not well correlated and do not give the same insights for policy designs. Realizing the difference is important to focus on the relevant information for each type of decision.

O-2236-02
From scenarios to climate action: insights from scenario-guided policy development across six global regions
J. Vervoort (1) ; M. Veeger (2) ; R. Peou (3) ; M. Muzammil (4) ; A. Palazzo (5) ; D. Mason-D’Croz (6) ; S. Islam (6) ; P. Hauser (7) ; P. P. Thornton (8) ; C. Jost (9) ; W. Foerch (10) ; P. Kristjanson (11)
(1) University of Oxford, Cgiar program on climate change, agriculture and food security/environmental change institute, Oxford, United Kingdom; (2) University for International Cooperation, San Jose, Costa Rica; (3) International Rice Research Institute, Hanoi, Vietnam; (4) University of Oxford, Oxford, United Kingdom; (5) International Institute for Applied Systems Analysis, Laxenburg, Austria; (6) ILRI, Nairobi, Kenya; (7) World Agroforestry Centre (ICRAF), Climate Change Science Domain. (8) CGAAR, Research programme on Climate Change, Agriculture and Food Security (CCAFS), ILRI, Policies and institutions for climate resilient food systems, Nairobi, Kenya; (9) World Agroforestry Centre (ICRAF), Climate change science domain, Washington D.C., United States of America

Scenarios can be a powerful approach to exploring future climate and socio-economic uncertainties. However, scenarios are not strategies – instead, they provide insight into the challenges and trade-offs that may arise in the future. To make anticipatory adaptation of agriculture-dependent livelihoods and food security more effective on the other hand.

We present a global research project that evaluates the use of scenarios for policy development in the context of climate adaptation, socio-economic development and food security through six case studies. First, regional scenarios were developed by stakeholders in six global regions: East and West Africa, South and Southeast Asia, Americas and Central Africa. Particular attention was paid to the integration of climate uncertainties and socio-economic pathways. The scenarios were then quantified using two global agricultural economic models, IMPACT and GLUE, and linked to the new global shared socio-economic pathways (SSPs). In each of these regions, an exogenous emissions trajectory was imposed on the SSPs. The scenarios were then used to explore potential futures and the respective patterns of individual and collective decision-making. The gaming method was used specifically to understand how the social actors might respond to climate change impacts on agricultural production, paying particular attention to the role of adaptive capacity and the role of climate policies in shaping future outcomes.

Climate change concerns are exceptionally pressing in agro-ecosystems, where social–ecological connections are particularly close. However, inherent climate uncertainties make anticipatory adaptation–decision processes particularly challenging. This paper draws on scenario analysis in order to understand how local level decision making processes in three rural communities in West Africa may unfold as climate change progresses.

Empirical evidence was collected using a game designed around future uncertainty with climate change. Participatory games based on scenarios provide a safe space in which to explore potential futures and the respective patterns of individual and collective decision-making. The gaming method was used specifically to understand how the social actors might respond to climate change impacts on agricultural production, paying particular attention to the role of adaptive capacity and the role of climate policies in shaping future outcomes.

Based on this novel method, the paper is able to make a number of contributions to the empirical and conceptual understanding of adaptation decisions in coupled social–ecological systems. Lessons can in particular be drawn on the importance of understanding the role and nature of socio-environmental change on the level and type of adaptation action. The data suggest that sudden and extreme events are more likely to trigger more reflexive and less fundamentally adaptation responses than gradual environmental degradation, with the latter implying a high risk or rigidity traps in the case study regions.
The research further allows drawing a number of methodological lessons, particularly with regards to the strengths but also weaknesses of participatory scenario methods. In order to arrive at wider conclusions, the lessons from the rural agricultural context in West Africa are juxtaposed with lessons learned in another project, where participatory scenario development has been applied by the authors in a very different setting, i.e. on adaptation trajectories in coastal megacities, jointly generated with adaptation and planning professionals. Recommendations for other researchers are formulated and amendments to the current literature discussed.

In search of analytically sound and socially viable energy strategies: linking stakeholder narratives with energy scenarios

E. Trunyteyte (I)
(I) Swiss Competence Center for Energy Research–Supply of Electricity, ETH Zurich, Zurich, Switzerland

Climate change mitigation requires a rapid transformation of the energy sector. Energy strategies that are both analytically sound and socially viable can lay foundation for this transformation. I will propose a set of scenario methods that enable development of such strategies by linking narratives of stakeholders and the public (to capture the social viability component) with quantitative energy scenarios (to capture the analytical component). After discussing the limitations of the conventional storyline approach (from many narratives to many scenarios), we will examine two alternative approaches: the first develops the narratives and scenarios simultaneously and then finds best matches (many narratives and many scenarios, side by side). These three approaches are illustrated with the case of regional and national energy strategies in Switzerland, electricity system transition pathways in the UK, and risk governance planning in the United States. The research further allows drawing a number of methodological lessons, particularly with regards to the strengths but also weaknesses of participatory scenario methods. In order to arrive at wider conclusions, the lessons from the rural agricultural context in West Africa are juxtaposed with lessons learned in another project, where participatory scenario development has been applied by the authors in a very different setting, i.e. on adaptation trajectories in coastal megacities, jointly generated with adaptation and planning professionals. Recommendations for other researchers are formulated and amendments to the current literature discussed.

Scenarios Exploring Climate Change based on Soft Computing

A. Batisha (I)
(I) Environment and Climate Change Research Institute, Cairo, Egypt

The study presents an integrated view of soft computing to solve Climate Change problems. Having a collection of methodologies, soft computing may take advantage of tolerance for imprecision, uncertainty and partial truth to achieve tractability, robustness and low Climate Change solution cost. The focus is to apply the highest quality analysis in application and convergence of the areas of Fuzzy Logic, Neural Networks, Self-Organizing Maps, Evolutionary Computing, Rough Sets and other similar techniques to address Climate Change complexities that may affect Our Common Future.

Scientific communities should work more together on understanding of future climate risks, Disaster reduction and emergencies, and Hazard mitigation. Models and observations of the climate system play an important role in protecting our future climate. Especially extreme events can disrupt society. The impacts concern increased risks of coastal, river, surface water flooding, and/or drought. Such issues may be considered by using Soft Computing Techniques: future sea level scenarios globally and regionally, future changes in storm surges, changes in precipitation regimes, and associated river discharge analyses of multiple threats to coastal areas and river delta due to climate change, measuring/recording climate change induced change, extremes and compound climatic events, and the role of soft computing in hazard mitigation and on possibilities to strengthen post hazard reconstruction with a long term adaptation perspective.

Climate change, socio-economic development, ineffective water policy and governance, and basin-wide climate risk management.
developmental interventions are causing increasing threats to the availability and access of fresh water for drinking, agriculture, ecosystem sustenance and industrial activities. Sea level rise, Stabilization and long periods of drought are posing challenges to optimization of freshwater supply and demand. Such issues may be considered by using Soft Computing Techniques: research on how river delta can be adapted to threats of Stabilization and increasing uncertainties in fresh water supply, including technical, economic and policy making measures that can be applied for improved fresh water management. Uncertainty about climate change increases the complexity of decision-making. Limits to the predictability of natural and societal processes prevent scientists from making firm statements about the possible consequences of adaptation decisions. This contrasts with the public’s expectation that decisions are based on second science. Such issues may be considered by using Soft Computing Techniques: bridging the gap between science and decision-making. Better methods and tools for assessing; simulating and communicating climate change at the environmental, social and economic costs and benefits of adaptation.

P-2236-02

Going beyond integrated assessment: big emitting nations and the 2°C target

A. Bows-Larkin (1) ; M. Sharmina, (1) ; J. Kuriakose, (1) ; K. Anderson, (1) ; S. Day (1)

This year, the United Nations Conference of the Parties in Paris is scheduled and will deliver an agreement on avoiding the 2°C warming associated with ‘dangerous interference with the climate system’. If such an agreement is reached, it will re-invigorate analyses of how global and national energy systems can deliver the rates of mitigation accompanying the 2°C threshold. Commonly such studies rely on detailed integrated assessment models combining physical and economic relationships to predict climate and energy systems. Typically these models optimise on the basis of minimum costs in developing ‘feasible’ scenarios in terms of technology, infrastructure and efficiency change, as well as providing longitudinal outputs related to parameters such as capital costs, carbon tax rates, etc.

This paper reflects upon the reliance of decision makers on the outcomes of these models, and their suitability for producing plausible outcomes. One criticism is aimed at their limited ability to explore future societies under the pressures of climate change mitigation and adaptation strategies, even that their economic parameters are underpinned by historical relationships fit for a world unperturbed by climate change. A second question whether their theoretical basis is appropriate for articulating the outcome of non-marginal change, when the very futures they are set up to explore involve non-marginal rates of change; for example radical cuts in CO2, severe climate change impacts. Quantifying societal responses within such models is a particular challenge. Finally, these models downplay risks through disregarding low-probability, high-impact events and their consequences, including wars and migration. It is argued here that as currently formulated these tools are unsuitable for modelling the revolutionary transformations necessary to stay within 2°C carbon budgets, or similarly, futures with higher levels of warming and subsequent impacts.

To address these deficiencies, this paper presents an alternative approach to contextually explore the possibility space appropriate for avoiding 2°C. In contrast to exercises that build future scenarios using ‘immutable’ relationships within and between the energy and climate systems, a more transparent and dynamic framing based on highly constrained cumulative carbon budgets is proposed. Building on previous assessments that use a similar approach by authors Anderson and Bows, this analysis is extended to Annex 1 and non-Annex 1 division to backcast what the remaining CO2 budget implies for the world’s top emitting nations. The analysis takes the top 25 nations, responsible for 85% of greenhouse gas emissions, and groups them based on the similarities within their energy systems. Using a range of explicit variables such as short-term CO2 growth, a suite of emission scenarios for these groups are developed, constrained within a range of 2°C carbon budgets. By varying the levels of near-term emissions from each group’s energy system, under a highly constrained CO2 budget, important sensitivities are revealed. Results demonstrate the significance of the rates of CO2 growth in the highest emitting groups, the importance of short-term change and the relevance of bunker-fuel emissions in shaping our collective futures. They also illustrate that only non-marginal change resulting in radical transitions across all energy systems can now be reconciled with the 2°C policy objective.

P-2236-03

The Integrating Assessment Modeling Community: overview, structuring and interactions with the IPCC expertise

C. Cassen (1) ; B. Cointe (2)

(1) CIRED, PARIS, France; (2) CIRED, Nogent sur Marne, France

The intellectual debates expressed by the Club of Rome about the “Limits to Growth” (Meadows, 1972) and the oil crisis in the 70s have given rise to energy-environment-economy (E3) models to explore the feasibility of long-term development pathways. The rise of climate change on the public agenda since the late 80s has prompted the need for quantitative assessment of mitigation strategies, in particular in view of the IPCC reports. Models gather different types of energy in particular IAMs (Integrated Assessment models). IAMs are simplified, stylized, numerical approaches to represent complex physical, social and economic systems, and the systems’ interactions. From a set of input assumptions they produce outputs in the form of quantified scenarios: energy system transitions, land use transitions, economic effects of mitigation, emissions trajectories. These scenarios are central to the work of the IPCC “Working Group III” on mitigation of climate change, and play an increasingly important part in the negotiation and elaboration of climate policies.

In this paper, we investigate the conditions of the production of such scenarios and the diversity of the models behind them. These models have been developed by an heterogeneous, interdisciplinary community of research. This paper analyses the development and the evolution of this community since the early 90s and provides an overview of the main models and research teams. The climate debate fostered the rise of a new generation of models in the vein of the first global and technico-economic models developed in the 80s. In 1989, the decade divide in the 90s was between macro-economic models (top-down) and more engineer styles models (bottom up). Bottom-up models give the priority to a detailed description of technologies and sectoral systems, while top-down models represent macro-economic consistency and may encapsulate a limited description of technologies. The gap between has narrowed and an increasing number of hybrid models are now combine comprehensive top-down representations of macro-economic processes with a technologically explicit bottom-up representation of energy systems.

We explain this narrowing gap as a result of the structuring of the IAM community. How did these models emerge as usable – through diverse and the intellectual debates among the IAM community organise as such, and what is it made of? This paper stresses the role of intercomparison modeling exercises under the framework of key institutions (for instance the Energy Modeling Forum coordinated by Stanford University, European Framework projects...). It traces the development of an epistemic community which participates, through the production of socio-economic scenarios, to the framing of the assessment of climate policies in group III of the IPCC. This history of the development of IAM relies on a mapping of existing models and modeling team, on interviews, as well as on an analysis of the content of the research programs conducted in these forums, the material produced (reports, articles, IPCC assessment reports in particular AR4 and 5...).

P-2236-04

Native American Vulnerabilities to Climate Change and the Emergence of Federal Mitigation Strategies

S. Day (1)

ABSTRACT BOOK
Native Americans in the United States face a variety of existential threats due to climate change. This paper presents a typology of the specific vulnerabilities these groups face, and explains why they are unique groups when it comes to programs to mitigate the effects of climate change. The variety of climate change vulnerabilities that include the well-documented problem of sea level rise and its effects on coastal communities, impacts of drought on such things as water availability and agriculture, increased riparian flooding due to shifts in rainfall patterns and vegetation change, and cultural impacts stemming from the loss of hunting and fishing for migratory species. Vulnerability patterns are furthermore complicated by the fact that the 566 federally-recognized Native American tribes vary considerably in terms of their populations, land areas, and resultant population densities. As semi-sovereign governments with land assets held in trust by the federal government of the United States, these groups represent an interesting problem for climate change mitigation, in that the federal government has specific obligations towards the protection of these groups. What this means for climate change mitigation is unclear. What does the federal government “owe” to a tribe whose land base is under threat due to climate change? Do certain mitigation strategies pose threats to the cultural fabric of the group, perhaps if mitigation involves relocation? After providing the basic typology of climate change vulnerabilities faced by tribes, this paper goes on to describe several mitigation programs currently in the implementation phase. These include federal-tribal land swaps and relocations, as well as renegotiation of water rights. Thus far, these programs have not been controversial due to the fact that the tribes involved were small in terms of population and land base. However, I argue that the political feasibility of this type of mitigation strategies are limited by several factors specific to the types of vulnerabilities being addressed. As an example, the successful negotiation of land swaps and relocation are fundamentally constrained by the availability of federal lands adjacent to affected tribes, and which are not under pressure from additional users. Polity, as a result, the potential for land swaps as a standard mitigation strategy is likely to be limited to small and geographically remote tribes, as land swaps must contend with the principle that land exchanges must involve similar-sized tracts of land. Moreover, larger coastal tribes that are closer to more urban areas are thus more vulnerable, both politically and environmentally, than the tribes that have thus far been able to negotiate mitigation programs involving land swaps. The federal response to issues involving water scarcity and other issues, on the other hand, are relatively less well-developed. For instance, while renegotiated water rights agreements are intended to strengthen the position of various tribes, this paper argues that these agreements do not in and of itself address the vulnerability of certain groups if there is no water to be had. Furthermore, the political conflicts in such situations are likely to be much more acute than in the other types of climate change issues faced by other Native American groups insofar that all stakeholders over a broader geographic region face the same underlying vulnerabilities. These type of situations represent zero-sum games and any concessions granted to Native American groups are likely to be perceived as unfair by other stakeholders. The paper concludes with a series of policy recommendations which suggest that a broad and flexible approach to climate change mitigation should be pursued, one which takes into account the direct and indirect causes of land use changes facilitate thinking about the possible futures (anticipation), getting new ideas and understanding different points of view (appreciation), as well as making decisions (selection). A first workshop has taken place in Tunisia and land use scenarios have been built. On top of that, global and regional level scenarios have been built with the support of a Scenarios Advisory Committee and their are the basis for discussions on possible consequences of land use changes on food security. The scenarios have been build combining hypotheses on direct and indirect causes of land use changes, and looking at interactions and retroactions between the variables. The foresight exercise has a wholistic approach...

Climate change is one of the important indirect drivers of land use changes. It impacts the food production capacity of ecosystems in several ways. It changes the time maturity of crops, it alters the distribution of land use, it changes the nutritious qualities of crops, it changes the time maturity of crops, it alters the distribution of land use, it changes the nutritious qualities of crops, it changes the time maturity of crops, it alters the distribution of land use, it changes the nutritious qualities of crops, it changes the time maturity of crops, it alters the distribution of land use, it changes the nutritious qualities of crops, it changes the time maturity of crops, it alters the distribution of land use, it changes the nutritious qualities of crops, it changes the time maturity of crops, it alters the distribution of land use.

The combination of the climate change scenarios with scenarios concerning the direct and indirect causes of land use changes show that food regime, cropping and livestock system, cropland and farm structures, will have to adapt to new situations.

P-2236-06

Geo-political maps of CO2(s) to facilitate scientific policy and public debate

K. De Pryck (1) ; T. Venturini (1) ; M. Deves (2) ; M. Robert (3) ; A. Reys (4)

(1) Sciences Po, Médialab, Paris, France; (2) Institute for Globe Physics, Paris, France; (3) University Paris Diderot, Paris, France; (4) Sciences Po Paris, Médialab, Paris, France

In the last decades, a humble chemical molecule has become one of the most important actors of modern contemporary life: carbon. CO2, increasingly used as a key marker for politics and economics both at the national and international level. As such, establishing thresholds for CO2 emissions is one of the main objectives of the UNFCCC (United-Nations Framework Convention on Climate Change).

This does not means, of course, that the CO2 has passed from the natural to the political sciences. It means that the molecule has assumed a variety of different meanings according to who use it. Chemists, biologists, geologists, soil scientists, physicists, climatologists, all have different CO2 definitions. And their definitions differ from those of the economists, geo-politicians and NGOs and probably...
even more from perceptions by the public opinion. If we had to design one single CO2 cycle, we would have to erase all these differences to obtain some ‘mean version’ that would be unrealistic.

Instead of trying to average these definitions, it would be much more interesting to find ways to compare their different meanings. Each of them designs and represents a specific vision of the world and orients future policies and actions. For instance, measurements of CO2 emissions entail different responsibilities when represented in terms of CO2 per GDP, CO2 per capita or consumption/production-based CO2.

We started by exploring the scientific literature and used advanced scientometric techniques to disaggregate and map the references associated with the keywords “CO2” or “carbon dioxide”. Our method consisted in:

• harvesting thousands bibliographical notices (299,629) mentioning “carbon dioxide” or “CO2” from ISI Web of Science,
• extracting all the references cited in the bibliographies of such notices,
• constructing series of co-citation networks (on various time-periods) in which disciplines emerge as tight clusters of references often co-appearing together,
• projecting the period on maps, together with other chosen metadata such as authors, keywords, subjects, countries and institutions.

A dozen of CO2 landscape maps were obtained showing the evolution of the research landscape concerned with CO2 through space and time. A first result to be discussed is the quick evolution of the key words around which research publications aggregate. Some interesting trends are observed (e.g. rise and fall of CO2 lasers in physics, movement from plant sciences to environmental sciences and the emergence of the climate change issue in the 1980s, development of geoengineering–related disciplines in the 2000s). We thought that the role played by different countries, institutions or individuals in different research fields (e.g. US dominance in environmental (and climate) sciences and China’s proximity with issues of carbon capture and storage). In order to complement and strengthen our analysis, we invited specialists to comment the maps.

At this stage, the qualitative-quantitative method we developed – empowered by digital computation and guided by expert knowledge – can explicit some of the multiple representations of CO2 from a research perspective. Future work will be the IPCC expertise is really representative of the rapidly evolving research landscape. We believe this exercise to be particularly useful as we approach the negotiating table.

P-2236-07

Probabilistic analysis to improve baseline GHG emission determination in a developing context: The case of Chile

M. Díaz (1); R. O’ryan (2); C. Benavides (3); J. Mallea (4)

(1) Universidad de Chile, Centro de Energía – Energy Center, Santiago, Chile; (2) Universidad Adolfo Ibáñez, Centro de Innovación en Energía, Santiago, Chile; (3) Energy Center, University of Chile, Santiago, Chile; (4) Universidad de Chile, Departamento de Ingeniería Industrial, Santiago, Chile

In developing contexts, uncertainty in most key variables makes it difficult to establish reliable baseline GHG emissions for the near and medium term future. Scarcity information, lack of models and high variability in the main variables are typical in this context. However, these baseline emission assessment requirements are increasingly required in the context of international negotiations of the Kyoto protocol and particularly the country must define and declare a baseline and a contribution to mitigation by 2015.

It is common to work with the best information available and obtain a “most probable” scenario, usually based on “reasonable” assumptions of values and trends in key parameters. It is also common to leave some cases and assume that these are equally probable, generating scenarios with a wide range of variation in results. Another possibility is using mean values, however in this case, proposals can turn out to be very difficult to reach or affect productive sectors significantly since they may not adequately reflect the existing variability. Depending on the assumptions, a wide range of variation in results can be obtained, making it difficult for policymakers to identify the risks associated to a specific policy.

Probabilistic analysis may be very useful for determining these baseline emissions, incorporating uncertainty in the variables and propagation of uncertainty through the different processes in which they are involved. In particular GDP growth, one of the main drivers of increases in emissions, fuel prices, technology penetration levels are variables frequently used in this estimations. Expert opinion can also be incorporated systematically to improve these information gaps.

For this reason, in this paper we compare the results of a deterministic and probabilistic analysis for baseline GHG emissions in Chile up to 2030, based on the results of the Mitigation Actions Plans and Scenarios (MAPS) project (www.maps.chile.cl). Considering the significant uncertainty attached to these values mainly due to the relevance for policy-making associated to incorporating uncertainty. Phase 1 and 2 results of this project show, using deterministic analysis, emissions will increase in the period between two to five times compared to current emissions. Probabilistic analysis allows fine tuning these results and richer conclusions for future policy-making by establishing GHG emissions that provide the policymakers with a given level of certainty. This provides the regulator with more freedom in defining a baseline which he/she will not later regret. Additionally, the results of the importance analysis of uncertainty allow establishing the variables where more information is required for better decision-making.

P-2236-08

Transition to sustainability: are normative participatory scenarios a useful tool? Two case studies in the Brazilian Amazon

AP. Aguilar, (1) R. Folles (2); A. Roberto (1); DC. Otávio (3); Emilie (4); P. Patrícia (5); B. Peter (6); B. Mateus (7); K. Elza (7); ED. Nora (1); T. Assiss (1); K. Kasper (8); C. Von Randow (9); B. Kruji (10); A. Coelho (11)

(1) National Institute for Space Research (INPE), Earth System science centre, Sao Jose dos Campos, Brazil; (2) UFPPA, Université Paris 3 Sorbonne Nouvelle, Belém/Paris, France; (3) UFPA, Numa, Belém, Brazil; (4) University of Aberdeen, Aberdeen, United Kingdom; (5) USP, São Paulo, Brazil; (6) Museu Paraense Emílio Goeldi, Belém, Brazil; (7) EMBRAPA Meio Ambiente, Campinas, Brazil; (8) Wageningen University, Wageningen, Netherlands; (9) Instituto Nacional de Pesquisas Espaciais, Ccst, Sao Jose dos Campos, SP, Brazil; (10) Alterra, Wageningen UR, Wageningen, Netherlands; (11) FAPESP, Belém, Brazil

Environmental scenarios were largely exploratory in the past decades, mainly at global and regional scales. Normative/backcasting approaches gradually become more popular and widely applied over the last decade, due to the strongly normative concept of sustainability. Backcasting can be defined as envisioning a desirable future, and then looking backwards in order to strategize and to plan how that vision of the future could be achieved. Here we present a normative participatory scenario approach conceived to explore what a «transition to sustainability» would mean (and require) in a heterogeneous and conflicting region such as the Brazilian Amazon. Scenario construction for the Brazilian Amazon has mostly focused on future deforestation trends at broad-scale. In this work, we explicitly included the social dimension in the scenario construction process, enforcing that all the sustainability dimensions (social, environmental and economic) are taken into consideration. Here we present a synthesis of the scenario process and a synthesis of the results of two case studies at different scales.

The first case study was developed on a settlement project in Pará State, with the specific goal to explore how participatory scenario methods could contribute to the strengthening of the participatory vision of communities, by demanding that the state authorities consider those perspectives and interests in the decision-making process. To PAE Lago Grande, a multi-scale approach was adopted, involving stakeholders at three communities and representatives of organizations at the settlement level. Through a series of structured workshops, the actions to reach the sustainable/desired future at the several scales were
Climate change geo-indicators for policymakers: downscaling for land-use planning in Caribbean Islands

J.R. Gros-Dusormeaux (1) ; F. Léone (2) ; P. Palany (3) ; M. Morell (4) ; P. Cantet (5) ; T. Lesales (6)

(1) Centre National de la Recherche Scientifique (InE), Umr 8053 (crplc), Schoelcher, Martinique; (2) Institut de Recherche pour le Développement, Umr 0007 (gred), Montpellier, France; (3) Méto-France, Service Antilles–Guyane, Fort-de-France, Martinique; (4) BALWOIS, Montpellier, France; (5) Institut National de Recherche en Sciences et Technologies pour l'Environnement et l'Agriculture, Umr rhx, Aix-en-Provence, France; (6) CIENCE, Paris, France

The Lesser Antilles are exposed to major and various hazards (earthquake, volcanism, hurricanes, floods, tsunamis, landslides, etc.). In a significant context of climate change, a set of institutional responses for the sustainable management of territories is being drafted. Recent works on the importance of using high-resolution model to study the climate change on small islands by Cantet and al. (2014), underlines the importance of the dynamical downscaling to study the impacts of climate change on the Lesser Antilles. The projections provided by the regional climate model suggest an increase in extreme rainfall and stronger hurricanes in a future of annual total precipitation, more frequent very heavy daily precipitation and a stronger 1-day maximum precipitation, whereas for the driving Global Climate Model, these trends are less intense. Within the framework of CARIBSAT program, a Multi–natural hazards CARIBSAT GIS was produced by the GRED research laboratory (University of Montpellier, France) and the IRD agency (Institute of Research for Development, Montpellier, France). The aim was to harmonize multiple sources of historical, scientific and geographical information. CARIBSAT GIS is useful to develop several sets of geo–risk and natural disasters indicators: natural hazards activity, human and socio-economic impacts, exposure levels. These geo–indicators are therefore helpful to elaborate territorial diagnosis and comparative risk analysis, at international or regional levels. In the poster, one main question will be: ways to combine risk and climate change in territorial diagnosis and comparative risk analysis? How and by which mechanisms do the actors, who have produced and manage regional knowledge, can participate in drawing up and adapting or changing the frameworks of decision makers final action, mitigation intervention as regards to climate change information?

P-2236-09

Social and economic tipping points in adaptation processes: Reason for concern?

M. Garschagen, (1) ; J. Birkmann (2) ; T. Welle, (2)

(1) United Nations University,, Institute for Environment and Human Security, Bonn, Germany; (2) Institute for Spatial and Regional Planning, University of Stuttgart, Stuttgart, Germany

Tipping points have become popular epistemic elements within the assessment of climate change. The study of tipping points helps decipher the complexity in climate change dynamics. Yet, despite the increasing engagement with tipping points in hazards and expected impacts there has been little work to empirically assess tipping points in adaptive capacity and adaptation processes. Along the same line, tipping points have been linked predominantly to large-scale bio-physical systems (e.g. the instability of land ice sheets and the breakdown of ocean circulation systems). This paper offers a new perspective on tipping points in social and economic systems at lower scales. Resulting knowledge gaps are particularly relevant for coastal areas and cities where socio-economic change is often rapid, coupled with heightened levels of exposure and vulnerability to climate change hazards.

Through its conceptual and empirical engagement with tipping points in adaptation processes, the paper aims at contributing to a better understanding of potential future adaptation trajectories. The analysis links two scales: First, a global index-based assessment of risk patterns and trends is presented with a national resolution, focusing in particular on the possibility and effect of large-scale adaptation tipping points. Second, an in-depth analysis of selected coastal urban areas in Asia, Africa and Europe is presented, drawing on ongoing research projects. The findings suggest that many types of tipping points in adaptation have been observed and identified. In order to model-based appraisals of adaptive capacity are explored. The paper concludes by discussing epistemological challenges for a future adaptation science as well as practical lessons for risk and vulnerability assessment and for model-based tipping points into adaptation ‘planning’ or into a global architecture of adaptation financing.

P-2236-10

Exploring the social-ecological dynamics of a coral reef resource system using bayesian belief networks

P. Leenhardt (1) ; J. Claudet (2) ; V. Stelzenmuller (3)

(1) UPMC, Paris, France; (2) CNRS, Usr 3278 criobe, Perpignan, France; (3) Thunen Institute, Hamburg, Germany

Social–ecological system approaches are now considered as the most relevant conceptual lens to establish biodiversity management strategies accounting for human–nature interactions. It reflects the dramatic paradigm-shift that environmental sciences have undergone in recent years, with increased recognition of the role of people in the dynamics of all natural ecosystems and of the feedbacks of ecological change on human uses and well-being. Social–ecological systems are complex adaptive systems characterized by complex feedback interactions, emergent properties, non-linear dynamics and uncertainty. While the science for modelling social–ecological systems is improving, transdisciplinary empirical studies aimed at investigating their dynamic under different scenarios of stressors or climatic changes are less intense. Here, we developed a transdisciplinary approach to investigating the social–ecological system of Moorea island, French Polynesia. Conceptual models were built through participatory, multi-agent, socio-economic models and Bayesian Belief Networks was developed using a 11-year long database and expert opinion to provide scenarios testing the effects of different stressors and management actions on the system defined by stakeholder groups. Preliminary results suggest that (1) the management of the social–ecological system of Moorea should be more targeted towards specific user groups, (2) more coordination is needed between marine and terrestrial agencies for a more
Climate impacts on adequate human livelihood conditions for well-being and development: framing uncertainties in projections of water availability

T. Lissner (1); CF. Schleussner (1); D. Reusser (2)
(1) Climate Analytics, Berlin, Germany; (2) Potsdam-Institute for Climate Impact Research, Potsdam, Germany

Climate change vulnerability and the consequent need for adaptation are unevenly distributed in the world and many developing countries are especially vulnerable to changes in climate. Climate change often adds on to existing development pressures that are responsible for low levels of social and economic welfare, increasing the vulnerability of such regions. Climate impacts may substantially reduce the adequacy of livelihood conditions, if adaptation and coping strategies are insufficient. Integrated approaches, including climatic as well as aspects of development are needed in order to identify adaptation requirements, opportunities and co-benefits. Ideally, development strategies as well as adaptation and mitigation should be complementary strategies, working towards improved livelihood conditions and sustainable pathways. The trans-disciplinary concept of «Adequate Human livelihood conditions for well-being and development» (AHEAD) provides a conceptual framework for the identification of limitations to adequate livelihood conditions and the consequential adaptation and development. The approach allows addressing several topical challenges of climate impact assessments, such as the integration of concepts from different disciplines, data integration as well as the combination of processes at different scales. A particular challenge for the assessment of climate impacts and adaptation needs lies in the treatment of uncertainties, which normally multiply along the assessment chain as has been shown by the recent Inter-Sectoral Impact Model Intercomparison Project (ISI-MIP). The methodological implementation of the AHEAD framework provides a way of dealing with these uncertainties based on the representation of gradual adequacy of conditions using fuzzy logic.

To illustrate the utility of the AHEAD approach, we assess the adequacy of AHEAD conditions on a global scale at national resolution. We focus in particular on the availability of water resources in adequate quantity and quality, which plays an important role in meeting human livelihood needs. We use multi-model water resource estimates from ISI-MIP to illustrate, how the approach can provide a way forward in dealing with the substantial uncertainty in water availability. Our analysis indicates that water availability limits the adequacy of livelihood conditions in some countries today, a situation that will aggravate over the course of the century; however for the majority of countries other aspects limit the adequacy of livelihood conditions. The presented approach shows how uncertainty ranges in modelling results may be framed in a way, which allows assessing their relevance with regard to water availability is considerable for many countries, but for more than a third of the countries this range is outside of critical thresholds for water security and overall AHEAD conditions.

Chaos in climate change impact estimates

E. Massetti (1)
(1) Georgia Institute of Technology, School of Public Policy, Atlanta, GA, United States of America

Global Circulation Models incorporate chaotic dynamics to reflect real-world weather patterns. This implies that extremely small perturbations of the climate system may generate very different weather patterns. Here I show that the SRES climate change scenarios generated by the Coupled Model Intercomparison Project (CMIP3) --- ubiquitous in the impact literature --- display strong chaotic dynamics at regional and sub-regional level, at least until 2065. Chaos is triggered by changes to historic forcing in the year 2000 and thereafter diverges strongly along different trajectories. This suggests that large uncertainty exists on how to link local climate change and global forcing. Furthermore, short- and mid-term differences in local climate change across SRES scenarios reflect chaotic dynamics rather than different forcing patterns. I show that the «chaos» in the climate scenarios generates a «chaotic» relationship between exogenous forcing and local economic impacts on agriculture. «Perturbed exogenous forcing» model ensemble would resolve this uncertainty.
International Scientific Conference     7-10 JULY 2015    PARIS, FRANCE

ABSTRACT BOOK

setting consists in using a Time-based long-term planning of pessimism of the optimal solution. Our experimental uncertainty budget, which gives control on the degree values. The number of potentially deviating coefficients of the worst-case parameters with respect to their nominal problem thus includes variables that traduce the deviations needs to be known. the robust counterpart of the initial such, only the extent to which parameters are likely to vary while stochastic or Monte-Carlo frameworks require the basic requirement for a robust solution is that constraints of in immunizing a solution against adverse realizations of uncertainties, scenario analysis (Babae et al, 2014) or Monte-Carlo analysis can be used to obtain distributions of model outcomes (Rosakis and Sourie, 2005).

In this paper, we introduce an alternative way to tackle uncertainty in optimization energy system models. We rely on robust optimization (Ben-Tal et al, 2009) to make many model parameters simultaneously uncertain. So far, this technique has been scarcely used in energy modeling (Babonneau et al, 2012). The contributions of the paper are twofold. From a methodological perspective, we argue that robust optimization techniques are appropriate for introducing cost uncertainty from many sources in long-term optimization models. We use recent results from operations research to economically interpret model outcomes, and assess the robustness of the model to economic parameters through optimization. From a policy perspective, we aim to evaluate the hedging potential of alternative technologies, making a step towards the identification of robust technology portfolios and policy designs.

Methodology In order to assess how deeply our model solutions are affected by uncertainty and to help the decision maker to design policies, we used recently developed in the field of operations research: robust optimization (RO). The general principle of RO consists in considering the adverse scenario affecting uncertain parameters within given uncertainty sets. The basic requirement for a robust solution is that constraints of the problem are not violated whatever the realization of the parameters in the set.

While stochastic or Monte-Carlo frameworks require the definition of probability density functions, the principle of RO consists of a set-based description of uncertainties. As such, only the extent to which parameters are likely to vary needs to be known. The robust counterpart of the initial problem thus includes variables that traduce the deviations of worst-case parameters with respect to the nominal values. The number of potentially deviating coefficients can be controlled through an exogenous parameter – the uncertainty budget, which gives control on the degree of pessimism of the optimal solution. Our experimental setting consists in using a TIMES-based long-term planning model of the French energy-transport system. We derive a dynamic implementation of the RO method. We perform a set of parametric runs by setting increasingly stringent (i) abatement objectives on CO2 from transport by 2050 and (ii) uncertainty budgets. We make primary energy prices and transportation investment costs uncertain.

Results and discussion We identify robust technological mitigation portfolios (compliant with the modeled policy objectives for any random realization of the uncertain parameters, which vary with both the required level of abatement and the degree of pessimism on the certainty of the exogenous price/costs projections. Key messages are that (i) the diesel-gasoline balance is affected by uncertainty, partly in response to system effects (ii) there is a general tendency to incorporate more biofuels (iii) natural gas (including biogas) and electricity pathways are relevant hedging option for low carbon caps; for stringent objectives, they are pushed out of the market. We then discuss policy insights, showing that if the uncertainty budget is reasonably low, robust confidence in projected impacts was considerable sense to incorporate a diversification logic in policy designs. However, if confidence is poor (high uncertainty budgets), then diversification may not be relevant.

The regional scale project focuses on the South East Queensland Climate adaptation research Initiative (SEQCARI) involving a multi-sectoral investigation of climate change adaptation in the South East Queensland (SEQ) region, comprising the sectors of urban and regional planning, coastal management, emergency and preparedness, emergency management and human health. The SEQ region has been identified as one of six vulnerability hotspots to climate change in Australia. The community of practice scale project focuses on planning for climate change adaptation involving regional bodies responsible for natural resources management in the East Coast Cluster of Australia. The East Coast of Australia comprises a wide range of landscapes that are vulnerable to climate change, including coastal areas, major catchments and agricultural areas that support two capital cities. The community scale focuses on the recovery phase of the Bundaberg community following the aftermath of category five tropical cyclone Yasi. Tropical cyclones affecting this area are likely to become less frequent but more intense in the face of climate change. At least two scenario planning workshops were conducted for each project to assist in the development and testing of proposed adaptation options. Adaptation options were developed through collaborative planning processes involving a range of stakeholders and aimed to reduce their vulnerability to future climate change impacts.

Findings indicate that at broader scales, such as regional level, exploratory scenarios enable the integration of multi-stakeholder and sector perspectives related to complex challenges such as climate change adaptation for human settlements. In particular, at that scale, scenarios provide opportunities for improved interaction between practitioners and understanding of sector-specific issues. In parallel, community of practice and community scales are better positioned for scoping more specific and tailored adaptation options. However, they lack broader interaction between different layers of actors involved in decision-making therefore hampering stakeholder’s ability to ascertain feasibility and envision the implementation of adaptation pathways. Multi-stakeholder scenarios processes are known to be time consuming given stakeholder’s unfamiliarity with the method. In the community scale, the main challenge that the stakeholder’s difficulty in grasping with both multi-dimension challenges related to and longer-term strategic thinking demanded for climate change adaptation.
Designing experiments for climate prediction

DA. Stainforth (1); J. Daron (2); S. Harrison (3)
(1) London School of Economics, Grantham Research Institute, London, United Kingdom; (2) UK Met Office, Exeter, United Kingdom; (3) University of Exeter, College of life and environmental sciences, Penryn, United Kingdom

Complicated global circulation models are used to simulate and study the climate system. Increasingly they are also used to make projections of future climate. For instance, the results of the Coupled Model Intercomparison Projects (e.g. CMIP5) play a significant role in the IPCC assessment reports and are often used to guide adaptation planning and impacts assessments.

Here we will discuss what we mean by climate prediction as a changing distribution will be illustrated using a low-dimensional climate-like mathematical system undergoing a forced change. The different roles that uncertainty in initial conditions can play in keeping the total costs of climate change as low as possible. More research is needed to assess the costs of inaction and the benefits of policy action, as well as the various uncertainties and risks involved. However, this should not delay policy action, but rather induce policy frameworks that are able to deal with new information and with the fact that their nature some uncertainties and risks will never be resolved.

References:

Climate change impacts and market driven adaptation: The costs of inaction including market rigidities

F. Bosello (1); R. Parrado (2)
(1) University of Milan, FEEM, and CMCC, Dep. of economics, Milan, Italy; (2) FEEM, Venice, Italy

To manage the complexity of economic assessments of climate change impacts, climate change research saw an increasing development and application of integrated assessment models (IAMs). Their distinctive feature is to describe in a controlled environment the “climate-change issue” in its entirety, i.e. connecting the climatic, the environmental and the social components. Two broad approaches can be identified in the economic quantification of climate change damages with IAMs. One makes ample use of reduced-form climate change damage functions. Basically, a more or less sophisticated functional form translates temperature increases into GDP losses. Parameterization of these functions derives from extrapolation of the impact literature or expert opinions. A different approach, often coupled with the use of Computable General Equilibrium (CGE) models, consists in translating climate change pressures into changes in quantity/quality of factors of production and/or in agents’ preferences driving demand and supply behaviour in the market. GDP losses are thus the direct outcome of the simulation and do not stem from an explicit function and its ad hoc parameterization.

More than twenty years of IA research produced a vast literature on the cost of climate change. Due to their obvious policy relevance, these estimates are surrounded by a heated debate, and many authors suggest that they are likely to underestimate climate change costs. Many features of climate change, environmental and social
responses are still uncertain and/or not well captured by IAMs. In fact, relatively small changes in climate sensitivity can greatly change the cost estimates from these models (Ackermann and Stanton, 2012; Anthoff and Tol, 2013). Quantitative modeling frameworks are able to measure important social phenomena like conflicts, mass migrations, disruption of knowledge, learning and social capital potentially triggered by climate change (Anthoff and Tol, 2013; Stern, 2007). IAMs emphasize impacts on GDP, which is often used as a welfare measure, captures flows and tend to overlook stock losses (Stern 2013). Risk and irreversibility associated to high damage low probability events is underplayed by the analysis which risk seriously bias downward damage estimates (Weitzman, 2007, 2008, 2009, 2010; Ackerman and Stanton 2012). IAMs tend to be overly optimistic in describing timing and scale of adaptation processes, disregarding the fact that agents may not use perfect information and for technological, economic, psychological and cultural characteristics may resist to some changes (Patt et al., 2010). All these caveats are particularly relevant when climate change impact assessments are conducted with CGE models. They provide a peculiar richness in the analysis of climate change costs, highlighting sectoral effects and, above all, tracking endogenous market adjustments and rebounds triggered by climate change shocks. But, at the same time, they are grounded on GDP, account just for marketable relations, typically model instantaneous and frictionless and time. Against this background, the assessment performed with CGE models tend to fall somewhat in the lower end of cost estimates.

This paper presents a simple exercise to address the following questions. Do climate change impact assessments performed with CGE models estimate lower GDP loss than reduced-form climate change damage based assessments? What is the role of market driven adaptation in determining these estimates?

We run a standard climate change impact assessment exercise with a recursive–dynamic CGE model updating estimates of an extended set of impacts for different temperature increases scenarios. Then we extrapolate a reduced–form climate change damage function. We show that, at the global level, this is not significantly different from that produced by some established hard-linked integrated assessment models when the same impact categories are included. Furthermore, we perform the same exercise reducing what can be defined “market driven adaptation”. In practice, we restrict the elasticity of input substitution in the production function, the substitutability of domestic and international inputs, and, finally, sectoral workforce mobility. We demonstrate that, notwithstanding these frictions increase the cost of climate change impacts, they do not change substantively neither the qualitative nor the quantitative picture.

K-2237a-03

Accounting for Climate Impact and Cost Uncertainty in Integrated Assessment Models

A. Markandya (1) ; F. Bosello (2) ; E. De Cian (2) ; J. Polanco (3) ; L. Drouet (4)
(1) BC3 Basque Center for Climate Change, Scientific director, Bilbao, Spain; (2) FEEM, Venice, Italy; (3) BC3, Bilbao, Spain; (4) FEEM, Milan, Italy

We develop a methodology that uses the concept of a risk premium from finance to account for risk aversion to climate change damages in the affected population. The premium is derived from the notion of risk aversion in the framework of expected utility theory, namely the amount that society would be willing to pay in order to reduce the riskiness of future damages. We estimate the risk premium for plausible average damage functions that are currently being used in Integrated Assessment Models to calculate the mitigation and/or adaptation response functions referred to as risk–adjusted damage functions and they have higher damages than the expected values used previously. We have calibrated three sets of risk–adjusted regional damage functions for three functional forms for three functions: low, medium and high. With low and medium coefficients of relative risk aversion equal to 1 and 1.5 the additional damage component is quite small. The damage addition due to risk aversion is highly nonlinear and it increases significantly when the coefficient rises to 2. It is also interesting to note that the risk premium varies from region to region, implying that the degree of the adaptation response will be region-specific.

The new functions are used to estimate what they imply for optimal adaptation and mitigation with different versions of the AD–Witch model. The results show that the percentage increase in allocation to adaptation is around 10–20 percent for values of the coefficient of risk aversion of 1 and 1.5, but rises to as much as 80–200 percent for a value of 2. The impacts of including risk in damage estimation on mitigation are interesting and somewhat different. In the cooperative solution mitigation is increased 5–10 percent with the higher damages for low values of risk aversion and 20–30 percent for higher values. Finally as far as the growth scenarios are concerned there appears to be little difference in terms of the impact that taking account of risk has on the calculations.

Further work is continuing to see the effects of the new damage functions at the regional level.

O-2237a-01

Global climate impacts: a preliminary economic analysis

JC. Ciscar (1); M. Perry (1); J. Pyroct (1); J. Abrell (2); M. Rozsai (1); W. Szewczyk, (1)
(1) European Commission (IPTS, EU JRC), Seville, Spain; (2) ETH, Zurich, Switzerland

Understanding the global implications of climate change at the appropriate country resolution is important for the policy process. The purpose of this presentation is to gain some first insights on the sectoral and regional pattern of the biophysical and economic consequences of climate change at the global scale, benefiting from the current bottom-up sectoral impact evidence. The study will consider a set of climate model runs and a limited set of impact categories within an integrated climate–biophysical–economic framework.

The main questions to be addressed are the following. Firstly, how important are the impacts of climate change for the big players in the international climate negotiations? Secondly, what are the distributional implications of climate impacts vis-à-vis Europe? Thirdly, what are the main uncertainties in the modelling and how they influence the results?

The project scope has several dimensions. Regarding the time horizon, it covers the climate impacts over the 2071–2100, compared to 1961–1990. The study considers few impact areas, for which there exist empirical bottom-up evidence: agriculture, coastal areas, and if possible, energy.

The study methodology is based on Results from process or bottom-up biophysical impact models (from the ClimateCost EU project and, possibly, the ISL–MIP project). The economic valuation of climate impact categories will be carried out in a coherent and harmonized way with an economic multi-country, multi-sector computable general equilibrium (CGE) model in order to enhance the comparability of the different damage patterns.

The authors have already conducted preliminary analysis of impacts in agriculture and coastal areas. The results indicate that there is a wide dispersion of impacts across the world, with strong geographical asymmetries.

O-2237a-02

Effort sharing taking into account adaptation costs and climate change damage

A. Hof (1); E. De Cian (2); G. Marangoni, (2); M. Tavoni (3); D. Van Vuuren (1)
(1) PBL Netherlands Environmental Assessment Agency, Department of climate, air and energy, Bilthoven, Netherlands; (2) FEEM, Venice, Italy; (3) Fondazione Enrico Mattei, Climate change and sustainable development programme, Milan, Italy

The ongoing discussion about the feasibility of maintaining global temperatures below 2°C encompasses not only the costs and benefits of achieving the target, but also the difficulty of reconciling regional efforts with the inequity of climate change impacts, if mitigation and adaptation actions, as well as residual damage from climate change,
climate risk management and cost estimation should take these interactions and dynamics into account.

Here, we present the dynamic damage propagation model called «acclimate». On the same time scale as the local events the model explores immediate response dynamics as well as the subsequent recovery phase of the supply network. While the pure damage propagation dynamics [1] as well as possibilities for demand changes and extinction of production [2] have already been described, we concentrate here on a major extension that includes price dynamics and local economic optimization.

The model focuses on analyzing the indirect effects of local perturbations without taking into account economic growth. Its agents, i.e. production or consumption sites, are organized in a production network based on multi-regional input–output data (Eora Mrio database) which constitutes the baseline and is assumed to be an optimal state with respect to the economic rational of the model. Direct damage as perturbation due to climatic extreme events the model explores immediate response dynamics as well as production and value chain dynamics. Part i: basic formulation of damage transfer and corresponding pillars of policy and why any individual policy which aligns different country and regional views and incentives? In most of the scientific literature, equity issues related to mitigation, adaptation, and impacts have been disconnected. Most studies on effort sharing have focused on fair distributions of mitigation costs without considering adaptation costs and residual damage. Our study aims to fill this gap by investigating which mitigation targets in 2030 and 2050 lead to equalizing the sum of mitigation costs, adaptation costs, and residual damage as share of GDP across regions.

We employ two alternative modeling frameworks combined with two sets of regional climate change impact functions. These models provide a mapping of the residual climate change damages of 2 °C and of the resulting adaptation costs, and allow exploring how emission rights should be allocated among regions as share of GDP across regions. We show that a 2 °C world leaves considerable residual impacts and adaptation costs. Sharing the burden of the total costs of climate change induced damage and adaptation costs, reshuffles the emission allocation compared to an effort-sharing regime based on mitigation costs only. The financial implications can be significant, with a total of additional resources in the order of 100–200 USD billions in 2030 would need to flow to the high impact countries in India, Africa, and Rest of Asia, by means of trading emission rights. Countries with lower-than-average impacts, such as OECD countries and China, would buy such rights thereby financing those transfers.

The above numbers assume a global carbon market being in place from 2020 onwards. Even though such a global carbon market with the implied sharing rules is not easy to implement, our paper suggests that accounting for the total costs of climate change and including adaptation and damage considerations could achieve an effort distribution being perceived fair by a wider group of countries.

**O-2237a-03**

**A predictive model of production loss under unanticipated shocks by extreme weather events**

S. Willner (1); C. Otto (2); L. Wenz (1); R. Bierkandt (1); A. Levermann (1)

(1) Potsdam Institute for Climate Impact Research, Research domain sustainable solutions, Potsdam, Germany; (2) Potsdam Institute for Climate Impact Research, Research domain climate impacts and vulnerabilities, Potsdam, Germany

Risks of extreme weather events like floods, heat-waves and storms are likely to increase due to global warming. Since world markets are highly interlinked and local economies extensively rely on global supply and value added chains, extreme weather in one place may have repercussions elsewhere. Accordingly, a comprehensive A predictive model of production loss under unanticipated shocks by extreme weather events

**2237b - Planetary Economics (2): expanding the horizons of economic sciences and the policy implications**

**K-2237b-01**

‘Planetary Economics’ The Three Domains and their implications

M. Grubb (1); J.C. Hourcade (2); K. Neuhoff (3)

(1) University College London, Institute of Sustainable Resources, London, United Kingdom; (2) International Research Center on Environment and Development (CIRE), Paris, France; (3) German Institute for Economic Research (DIW Berlin), Berlin, Germany

This paper summarises and outlined evidence for the economic framework developed in the book Planetary Economics. It maps out three domains of decision-making, each of which involves different actors across regional and for which our understanding rests on different theoretical foundations. Each operates at different scales of time and social entities: they are complementary, not competing, explanations of diverse economic phenomena. For this session, the paper will also tentatively map different economic theories on to this framework.

The paper will then explain the unique characteristics of energy and climate change issues which make all three domains simultaneously important, and indeed argue that the issues raised span all three domains in approximately equal measure. The paper will also suggest that understanding the different domains help to explain the extremes of cycles in international energy markets and the poor history of energy forecasting.

The paper will then outline lessons on the three corresponding pillars of policy and why any individual policy pillar has been relatively ineffective. This will call for a new perspective on the idea of sustainable development, corresponding to the need for policy packages spanning all three are credible, economically efficient and environmentally effective and hence, politically feasible. The concluding part of this overview talk will touch on the international dimensions, in which each pillar would raise different aspects of international cooperation.
K-2237b-02
Discussion on the «Three Domains» framework of Planetary Economics

R. Guesnerie (1)
(1) Paris School of Economics, Paris, France

Will present a discussion of the Economic framework presented in the book «Planetary Economics» and debate the merits (or not) of its approach and the resulting policy prognosis

O-2237b-01
Evaluating Common Futures: Rethinking Prescriptivism and Descriptivism

K. Mintz-Woo (1)
(1) Doktoratskolleg – Climate Change, Philosophy, Graz, Austria

Stern’s (2007) report has engendered an interesting methodological debate among climate economists. In evaluations of climate policy, assigning values to some key moral parameters (e.g. in the Ramsey formula, the pure rate of time preference δ and the elasticity of marginal utility of consumption η) weights the interests of future generations more or less strongly. This makes it possible to conclude about the evaluation of damages and how imperative it is to respond to these damages.

In IPCC SAR WG3, Arrow et al. (1996) called the participants of this debate prescriptivists and descriptivists. Prescriptivists like Hutt (1940); Manne (1995); Nordhaus (1994, 2008) think that, by appealing to (empirical) market data, they can avoid value judgments. This view contrasts with prescriptivists (e.g. Arrow et al. 1996; Broome 1994, 2012; Dasgupta 2008; Stern 2007), who have argued that explicitly weighing the moral import of parameter assignments is an unavoidable part of addressing these types of long-term policy evaluations.

In this presentation, I have two contributions. First, I intend to help classify these methodologies among ethical theories, to help incorporate moral philosophical contributions. Second, in the case of the Ramsey framework, I introduce new worries for both the descriptive and prescriptive positions. These worries come from application of recent behavioral psychological theories: prospect theory and heuristic theory.

First, to understand the positions in a philosophical context, it is necessary to recognize that there is an important presupposition underlying the debate. I argue that economists have a particular metaethical orientation with respect to assigning values to such parameters: they are subjectivist.

I argue further that the two economic groups (descriptivist/ prescriptivist) represent a disagreement between two subjectivist views: social constructivism and expert judgment. However, there are well-known economic problems with the descriptive methodology of assigning values to these moral parameters based on market data alone (Arrow et al. 1996; Broome 1994). First, we do not observe a perfectly competitive market, and market distortions prevent price signals from reflecting the full social costs. Second, it is not clear that individuals make market decisions with consideration of future generations; it is much more plausible that individuals are acting on personal time preference. Third, we do not see safe assets with maturities on climate impact timescales.

To avoid these issues, one might suggest that the moral parameters in the Ramsey formula be investigated directly from market participants. There is a shortcut with η, for example, since under utilitarian assumptions, η characterizes both inequty aversion and risk aversion. Since the experimental paradigms for testing risk aversion for individuals are well-understood, one might try to avoid these issues, one might suggest that the moral values to these moral parameters based on market data.

Methodological foundations of policy-making in sustainability transitions

JF. Mercure (1); H. Pollitt, (2); N. Edwards (3); J. Viñuales (4)
(1) University of Cambridge, Land Economy, Cambridge, United Kingdom; (2) Cambridge Econometrics Ltd, Cambridge, United Kingdom; (3) The Open University, Environment, Earth and Ecosystems, Milton Keynes, United Kingdom; (4) University of Cambridge, Cambridge, United Kingdom

Policy-makers currently face unprecedented challenges and uncertainty when taking decisions that simultaneously affect economic development, technological change, and the environment. A lack of consensus on the impacts of climate policy in this complex interacting system has paralysed the policy-making process, and policy indecisiveness has generated stagnation in investment, technology, and development. It is not clear to policy-makers how to reconcile economic policy supporting growth with climate change mitigation, and it is not clear how effective policies are likely to be.

This paper argues that policy-making based on conventional equilibrium science and economics is not fine-grained enough to capture the complexities of real-world human behaviour and its diversity, leaving a wide uncertainty gap for policy-making. We suggest that the use of dynamical methodologies involving complexity science coupled to better uncertainty analysis can provide appropriate tools to understand policy issues that involve a high degree of cross-sectoral interaction, and even to infer the behavior of agents, even at the aggregate level. This is to be used in a feedback loop with researchers in policy and law, in order to test potential policy packages while assessing their feasibility in the policy process.

We describe how policy-related interactions between each of three critical interrelated areas: technological change, the socio-economic, and the natural environment, could be dynamically represented in much greater detail, allowing better representation of feedback processes related to policy choice. We describe what impact these developments would have on our predictive power and ability to constructively inform coupled technology–economy–environmental policy–making aimed at addressing climate change. We identify three areas of environmental policy where the high degree of behavioural correlation (positive re-inforcing feedbacks) and/or behavioural diversity makes their analysis impractical using conventional methods, and where the application of this methodology could be determinant for gaining appropriate insight for policy making: (1) the analysis of green growth, (2) cross-sectoral impacts of sector specific policies (e.g. biofuels), and (3) the effectiveness of policy for emissions reductions in sectors based on behaviour change (e.g. transport). Providing a concrete example, we suggest how a wider adoption of this approach could provide a step change in our ability to address the complex policy problems raised by sustainability transitions.
A framework to manage national decarbonization regimes

D. Kammen (1); JP. Carvallo, (1); P. Hidalgo-Gonzalez, (1)

(1) University of California Berkeley, Energy and resources group, Berkeley, United States of America

There is widespread agreement that mitigating global warming to prevent disruptive climate change requires nations or regions to internalize the global externality of anthropogenic carbon dioxide emissions. The most straightforward approach is to establish a price on carbon emissions, either directly through a carbon tax or indirectly through a cap-and-trade market mechanism. Several studies have identified an “optimal” price of carbon that depends largely on intertemporal consumption preferences (notably discount rates) and the estimated “damage function” that changes in weather, crop yields, and productivity, among others, impose on the global economy. These models, however, provide little theoretical insight into the dynamics of the decarbonization transition and they cannot inform the consequences of different carbon prices in the evolution of a socio-technical system. Many jurisdictions are considering incremental carbon prices without acknowledging the existence of technological tipping points triggered by specific carbon prices that suggest faster and more aggressive earlier action. We use high temporal and spatial resolution model SWITCH (see, e.g. Mileva, et al., 2013; Carvallo, Hidalgo–Gonzalez, and Kammen, 2014) to study the effect of the trajectories of prices for carbon emissions on the evolution of power systems. We have developed this linear programming optimization tool and utilized it to examine energy and climate objectives for distinct models of four different regions: the Western U.S., China, Chile, and Nicaragua. In each of these regions we find a common pattern of non-additive effects of increasing carbon prices and non-linear/ non-decreasing marginal abatement costs. Despite the significant differences in the current energy mix and local resources in these regions, we find that tipping points at ~$30/ton and ~$60/ton lead to significant transformativ phases in each system. Specifically, as these carbon prices are reached we observe significant changes in the energy investment portfolio that would not likely have taken place with simply small, incremental, changes in carbon prices. Our analyses for each particular region suggest significantly different socio-technical evolution pathways for each area depending on an initial choice of carbon prices and its interaction with other policies. For example, in Chile carbon prices below $30 favor entrance of natural gas, while higher prices make renewable energy sources economical but impose different operational restrictions in the grid that require a different set of investment decisions. In the case of China, a high-adoption of renewable energy technologies and a carbon price below $60 is sufficient to define before and after a $10/ton price respectively, with major transmission infrastructure implications. We propose a framework of decarbonization regimes with four “drift phases” in each system: a natural stage and a carbon phase; a second stage with higher renewable energy penetration; a third stage defined by earlier retirement of coal plants; and a four stage with minimal marginal gains from higher prices. We use this framework to recommend appropriate supplementary environmental and technology policies to achieve mitigation goals.

References:


K-2238-01

Collaboration of Indigenous Science and Western Science to Protect Landscapes and Our Common Futures

A. Poelina (1)

(1) MADJULLA, PO BOX 2747, Broome WA , Australia

Indigenous people of the world have unique knowledge systems that can contribute to all fields of scientific endeavors, particularly of generational experiences of being living witness to changing biodiversity and cultural landscapes as documented in our report titled Indigenous Engagement with Science towards Deeper understanding (see http://www.innovation.gov.au).

The major challenge of generating and maintaining Indigenous knowledge systems and intergenerational practice is not simply an issue of science engagement; it is an issue of international importance for the earth’s co-existence with humanity. The solutions presented by Indigenous researchers/scientists, and knowledge holders are founded in a trans-disciplinary approach of collective wisdom, an approach that recognizes and celebrates unity in diversity. The opportunity needs to be realized to invest in future partnerships which value and include Indigenous and western scientist/researchers and practitioners working together.

These partnerships must recognize and respect the earth has rights and we as world citizens must guarantee custodianship of the commons, reliable prosperity and sustainable world development. The United Nations Declaration of Human Rights (1948) promotes the wellbeing and sacredness of all life not just human life (see http://www.un.org/en/documents/udhr/ ). In the words of twenty Indigenous Philosophers in the Redstone Statement (2010), we are at a tipping point, and it is the time before essential for non-Indigenous and Indigenous, native and non-native people to act now, to hold and care for Mother Earth in order to protect the sacredness of all life (see http://ww.indigenousenvironmentsummit10.unt.edu). This world belongs to all of us and we must again learn to live, love and work together to protect the sacredness of all life.

As traditional custodians in Australia we recognize and value the protection of all inhabitants who are connected to ancient geological and living water systems; rivers, arteries giving life to our dry sun burnt country. We have a responsibility as scientist, researchers and practitioners to generate multiple futures of information and practice to inform our role not as activist but rather as actionist. I am passionate about working in a dialogic action way to bring about transformational change in the recognition and promotion of the multiple values of this uniquely rich Australian cultural landscape. Late last year with fellow Australians we showcased and shared the places we love, see https://www.youtube.com/watch?v=V8h0mwwzuwl

The Kimberley region of Western Australia is considered one of the last great wildernesses of the world. Vast areas of the region were National Heritage Listed in 2011 for multiple world values containing vast ramsar wetlands a rich feeding ground for extensive species of migratory birds, the world’s largest dinosaur footprints and extensive trackways of prehistoric wildlife, ancient geological and living water systems; rivers, lines, rich ecosystems, and unique living Indigenous cultures co-existing with Asian and European heritage. We need transparent participatory planning, which values existing natural assets as capital and indigenous people in planning. My vision is the planning, development and delivery of a Marowuddarra (Fitzroy River) and the Broome Coastal Global Geo Park. Investment needs to be mobilised to conduct a feasibility study and build on the recognition of national cultural and environmental heritage landscapes. The time is right to build a body of evidence, for valuing these multiple assets as a geo world parks. We need to map alternative strategies for innovation and diverse economies on country if we want reliable prosperity and a sustainable common future against climate chaos.
Indigenous and Non-Indigenous Collaboration: Essential for Addressing Climate Change in the 21st Century

J. Hook (1)
(1) Citizen of the Cherokee Nation, El Indio, Texas, United States of America

Indigenous peoples worldwide possess extensive knowledge that is essential for environmental and human preservation in the coming century. Many scientists, both Indigenous and non-Indigenous, believe that we are at a critical point in maintaining the health of the environment, and consequently, of humanity, and that action must be taken immediately. In order to best protect the environment, and consequently, of humanity, and that both indigenous and non-indigenous, believe that we knowledge that is essential for environmental and human states of america (1) Citizen of the Cherokee nation, el indio, texas, United States.

In meetings with Indigenous communities in Sarawak (Malaysia) subsequent to the tsunami, with the Tatar-Baskiri villagers of Ufa–Shigiri (Siberia, Russia), and with many American Indian Nations in the central United States, I have heard shared concerns about cultural preservation, protection of Indigenous land, and a desire to engage with other Indigenous peoples and with Non-Indigenous leaders. Exploration of these shared issues led to meetings for mutual dialogue, and from 2007–2010 four annual Indigenous Student Videoconferences were held. Participants from Comanche and Kiowa American Indian Nations, Siberian Baskiris and Tatars, and Sarawak indigenous communities discussed Climate Change issues and related impacts on their communities. They shared various culturally-specific responses. Simultaneously, Traditional leaders expressed the belief that environmental threats needed to be addressed immediately. These concerns were clearly articulated in 2010 through the "Redstone Statement," a product of the International Summit on Indigenous Environmental Philosophies: American Indigenous Community of central Oklahoma, United States. Individuals from Indigenous communities met initially to compile case studies of climate change impacts. In the first meeting, however, a representative from the American Indian Nation challenged us to draft a statement articulating perspectives on environmental concerns and necessary responses. The subsequent process produced a consensus document describing a critical "tipping point," the product of environmental and cultural imbalance. The document was translated into Spanish and Russian, and is being used as a basis for education and action effectively.

Effective partnerships are only possible when «Western» scientists seek to understand and respect the concerns expressed by Indigenous voices. Non-Indigenous scientists, policy-makers and politicians must recognize the importance of Indigenous participation in planning and implementing mitigation and adaptation efforts. This can only be accomplished if the non-Indigenous put effort into learning how to work effectively in Indigenous settings. An understanding of cultural perspectives such as holistic world-views, livelihood and knowledge is to be ensured through policy frameworks. In this discussion I propose to provide a framework for traditional ecological knowledge security through innovative market and non-market incentives and to plan, explore options, draft strategies, and begin implementation projects.

There are examples of successful collaboration. The U.S. Environmental Protection Agency’s Tribal Science Council began bringing Indigenous scientists and knowledge-keepers together with non-Indigenous scientists for collaborative efforts in 1999. Effective partnering is not only possible, it is essential!
Integration of Indigenous Knowledge with ICTs in coping and adapting to effects of climate change and variabilty on Agriculture in Kajiado County, Kenya

C. Maney (1)

(1) University of Nairobi, Agricultural economics, Nairobi, Kenya

Climate change threatens production’s stability and productivity. In many areas of the world where agricultural productivity is already low and the means of coping with adverse events are limited, climate change is expected to reduce yields at lower levels and make uncertainties in agriculture higher. To help in coping with the negative effects of climate change, local people employ traditional indigenous knowledge based practices. This local based knowledge, which has evolved over several hundreds of thousands of years in tandem with the domestication of plants and animals, is critical for responding to climate change and variability effects at the local level. ICTs have the potential improve access to this knowledge among other relevant information and social networking opportunities. The research was carried out to assess relevant Indigenous knowledge used by Indigenous people to cope with climate change and variability effects therefore managing risks and uncertainties in agriculture as well as evaluate opportunities for utilizing ICTs to communicate this information. Results indicates that farmers have shifted the farming activities, drought tolerant crops, rain water harvesting, irrigation, use of organic manure, traditional methods of treating crops pests, and disease, change in planting time, preservation of pastures, indigenous food preservation methods, vaccination farmers are also increasingly relying on their own indigenous knowledge in predicting weather patterns compared to scientific knowledge. Various communication mechanisms taking advantage of ICTs such as radios and mobile phones are emerging as viable tools for dissemination of relevant information to the farmers because they are affordable and use of local language which is easily understood by farmers.

“Blue-ice”: Framing climate change and reframing climate change adaptation from the Indigenous peoples’ perspective in the northern boreal forest of Ontario, Canada

D. Golden (1); P. Smith, (1); CA. Audet, (2)

(1) Lakehead University, Faculty of Natural Resources Management, Thunder Bay, ON, Canada; (2) 90 Anemki Place, Office of the regional chief, Fort William First Nation, ON P7L 1L3, Canada

The northern boreal forest in Ontario, Canada, in the sub-Arctic above the 51st parallel, is the territorial homeland of the Cree, Ojibwe, and Ojicree Nations. These Nations are represented by the political organization Nishnawbe Aski Nation (NAN). January 6–March 31, 2011 the researchers and NAN collaborated in a study to record observations of changes in the forest environment attributed to climate change and share and exchange information and perspectives about climate change. Data were collected from ten First Nation communities across a geographic area of ~110,800 km² (43,000 mi²). We explore climate change impacts through the lens of “blue-ice,” a term embedded in their languages across the fieldwork area and reframe adaptation in the First Nation’s persooned worldview. Changes in blue-ice on the landscape is affecting transportation in traditional activities such as hunting and fishing, as well as the delivery of essential community supplies. The word ‘adaptation’ linked to local level. ICTs have the potential improve access to this knowledge among other relevant information and social networking opportunities. The research was carried out to assess relevant Indigenous knowledge used by Indigenous people to cope with climate change and variability effects therefore managing risks and uncertainties in agriculture as well as evaluate opportunities for utilizing ICTs to communicate this information. Results indicates that farmers have shifted the farming activities, drought tolerant crops, rain water harvesting, irrigation, use of organic manure, traditional methods of treating crops pests, and disease, change in planting time, preservation of pastures, indigenous food preservation methods, vaccination farmers are also increasingly relying on their own indigenous knowledge in predicting weather patterns compared to scientific knowledge. Various communication mechanisms taking advantage of ICTs such as radios and mobile phones are emerging as viable tools for dissemination of relevant information to the farmers because they are affordable and use of local language which is easily understood by farmers.

Forest Carbon in Amazonia: The Unrecognized Contribution of Indigenous Territories and Protected Natural Areas

W. Walker (1); A. Baccini (1); S. Schwartzman (2); S. Rios (3); MA. Oliveira-Miranda (4); C. Augusto (5); M. Romero Ruiz (6); C. Soria Arrascos (3); B. Ricardo (5); R. Smith (3); C. Merker (2); JC. Jintiach (7); E. Vasquez Campos (7)

(1) The Woods Hole Research Center, Falmouth, United States of America; (2) Environmental Defense Fund, Washington D.C., United States of America; (3) Instituto del Bien Comun/IBC, Lima, Peru; (4) Provita, Caracas, Venezuela; (5) Instituto Socioambiental/ISA, Sao Paulo, Brazil; (6) Fundacion GAIA Amazonas, Bogotá, Colombia; (7) Coordinadora de las Organizaciones Indígenas de la Cuenca Amazónica/COICA, Quito, Ecuador

More than half (52%; 4.1 million km²) of Amazonia’s tropical ecosystems are contained within an extensive network of Indigenous Territories (ITs) and Protected Natural Areas (PNAs) spanning nine South American nations. These cornerstones of Amazon conservation are widely recognized for their exceptional biological, cultural, and linguistic diversity, and serve as both social and natural barriers to frontier expansion and fire. Carbon sequestration is a widely-acknowledged and increasingly-value function of tropical forest ecosystems; however, until recently little information was available to assess the carbon storage capacity of Amazonian Indigenous Territories (ITs) and Protected Natural Areas (PNAs) in a global context remained either lacking or out of reach. Here we part of a novel north-south collaboration among Amazonian indigenous and NGO networks, scientists, and policy experts, we link newly compiled spatial data sets on pantropical aboveground forest carbon density, Amazonian ITs, and PNAs to an international carbon budget strategy from current pressures and/or near-term threats. We show that the nine-nation network of nearly 3,000 ITs and PNAs stores more carbon above ground (47,363 Mt) than all of the Democratic Republic of the Congo and Indonesia combined (40,797 Mt), and despite the ostensibly secure status of these conservation cornerstones, a conservative risk assessment considering only ongoing and planned development projects puts nearly 20% of this carbon at risk, encompassing an area of tropical forest larger than Colombia, Peru, and Ecuador combined. Our analysis suggests that the carbon stored across these landscapes is of a magnitude not previously appreciated in global terms, and is sufficient to either destabilize or contribute to the stabilization of the planet’s atmosphere depending on the collective impact of ongoing and planned development projects. International recognition of and renewed investment in this globally vital network are therefore critical to ensuring their continued contribution to maintaining cultural identity, ecosystem integrity, and climate stability.

Traditional knowledge and benefit-sharing in the 2015 agreement

A. Savaresi (1)

(1) University of Edinburgh, School of Law, Edinburgh, United Kingdom

Scientists have increasingly recognized the role of traditional knowledge as a means to adapt to climate change. Yet, the international climate regime presently says nothing on how traditional knowledge is to be deployed and protected to tackle climate change. This state of affairs may, however, be about to change. States are considering including references to the use of the traditional knowledge of indigenous and local communities in the new international agreement on climate change to be adopted in December 2015.

While it is too early to say whether references to traditional knowledge will be included in the new climate agreement, it is important to reflect on the implications of this possible development in the light of extant international instruments, especially those concerning biodiversity and human rights, which establish obligations to protect, maintain and promote traditional knowledge. This paper will therefore reflect on the scope for elaborating a common approach to the use of traditional knowledge under the climate regime, building on extant international law.
One area of crucial legal development on traditional knowledge is that concerning the interplay between the consent of indigenous peoples and fair and equitable benefit-sharing, as means to recognise, support and reward indigenous peoples and local communities for the contribution of their traditional knowledge to addressing global challenges. The Convention on Biological Diversity (CBD), for example, requires its Parties to promote the application of traditional knowledge with the approval and involvement of the knowledge holders and to encourage the fair and equitable sharing of benefits from its use with indigenous peoples and local communities. The Nagoya Protocol on Access and Benefit-sharing to the CBD requires its Parties to ensure that the use of traditional knowledge associated with genetic resources for research and development purposes (including for the development of climate-related technologies) is subject to the prior informed consent (or approval and involvement) of the indigenous peoples and local communities, as well as to benefit-sharing. Equally, the United Nations Declaration on the Rights of Indigenous Peoples asserts indigenous peoples’ right to maintain, control, protect and develop their traditional knowledge.

Presently, the negotiating text for the 2015 agreement mentions traditional knowledge in connection with adaptation to climate change, capacity building, and technology development and transfer. It does not say that indigenous peoples and local communities should receive a share of the benefits accrued from the utilization of traditional knowledge, or that they should consent before others can make use of such knowledge. The proposed paper will investigate how the law and practice emerged under the CBD, the Nagoya Protocol, the ITPGR and international human rights law could or should influence the development of the climate regime with regard to the use of traditional knowledge for climate adaptation purposes. It will argue that biodiversity and human rights law and practice embody internationally agreed understanding on matters upon which states have already reached painstakingly negotiated consensus. As Parties to the climate regime consider including traditional knowledge in the 2015 agreement, it is important to consider lessons that can be learnt from extant approaches to account for crucial equity considerations associated with the use of traditional knowledge.

**P-2238-01**

**Quantitative analysis of Greenhouse Gas (GHG) as a Milestone Towards Negative Emissions in Egypt**

A. Batisha (1)

(1) Environment and Climate Change Research Institute, Cairo, Egypt

Greenhouse Gas (GHG) analysis has been developed with the objective of providing an integrated perspective on Environmental sustainability. Emission baseline has been analyzed by sector based and macro sector based sectors; Energy, Industrial Processes and Product Use, Agriculture, Forestry and Other Land Use and Waste. Data has been collected from available public sources (local and international). A web-based IPCC Inventory Software supporting users of the IPCC Guidelines Categories may be calculated. Additional support to the greenhouse gas emission inventory community by giving inventory compilers a platform for all the current and past data they need, including a wide range of emission factors has been provided by means of the IPCC Emission Factor Database (EFDB). All Greenhouse Gas emissions divided into IPCC Guidelines Categories may be calculated from sectoral tables. National Key Category Analysis is implemented by performing a quantitative analysis of the relationships between the level and the trend of each category’s emissions and removals and total national emissions and removals. The paper concludes that Sharing of research information may enable the African countries to use or develop emission factors that are more applicable for their specific conditions. Its structure factors and may help to improve the quality of GHG inventories in a cost-effective way.

**P-2238-02**

**Toward a transdisciplinary framework for inter-relating indigenous knowledge systems and disaster risk reduction**

MA. Baudoin (1); S. Athayde (2); S. Lambert (3); V. Okorie (4)

(1) Climate and Development Initiative, Bielefeld, Germany; (2) Town, South Africa; (2) University of Florida, Center for Latin American studies, Gainesville, United States of America; (3) Lincoln University, Christchurch, New Zealand; (4) Obafemi Awolowo University, Ile, Nigeria, Federal Republic of Nigeria

Perceptions of natural hazards and climate change vary across regions, societies and culture. While "western" expert-based knowledge focus on measuring, defining and forecasting hazards’ occurrence, frequency and localization, local perceptions at the community level - often referred to as "indigenous knowledge" (IK) - embed a context-specific and holistic view of natural, climate-related and human-made hazards and disasters. Indigenous knowledge systems intertwine cultural, symbolic, technological knowledge, natural resource management practices, beliefs and worldviews in perceiving, preparing and managing disasters.

This talk presents the preliminary results of a follow-up project from the Risk Interpretation and Action (RIA) Fellows of the International Social Science Council, involving indigenous and non-indigenous researchers and practitioners. Acknowledging the diversity of perceptions and understandings of risks, this collaborative work aims to develop an exploratory transdisciplinary framework drawing from literature review as well as from experiences and challenges faced by indigenous peoples in the developing world. The framework can be applied to foster dialogue and guide research and policy-making involving indigenous peoples in disaster risk reduction (DRR) and climate change adaptation (CCA), recognizing limitations and power issues in coordinating different knowledge systems, and respecting indigenous peoples’ self-determination, worldviews and concerns.

With an objective to enhance cross-disciplinary learning, the proposed framework offers a broader understanding of disaster risks among indigenous people, scientists, practitioners and decision-makers. Its structure encloses a core sector (and adapts) the usual three phases of the DRR process, represented by indigenous symbols: preparedness (pre-disaster); response (during disaster); and recovery (post-disaster); adding a fourth transversal component, critical during the three phases, and related to framing, understanding and fostering dialogue across knowledge systems. Thus, the framework distinguishes common and contrasting features of DRR and CCA across diverse regions, cultures and types of disasters; it presents nuances of ‘risk perception’ and ‘risk interpretation’ among indigenous communities in different countries and contexts, as well as their creative responses or ‘risk action’.

The outcomes of this study will be used to connect, foster exchange of ideas and experience, and facilitate training and learning among representatives of indigenous communities who face natural, industrial and climate change-related hazards. Moreover, this research contributes to foster transdisciplinary dialogue and research on indigenous, academic and practical knowledge systems towards DRR and CCA in a global scale.

**P-2238-03**

**The Coastal Community as Context for Culture-Based Science Literacy**

H. Buenvenida (1)

(1) Department of Education, Science Education, Roxas City, Philippines
People in a community who are closely connected to the local land base, know the history and stories of their surroundings. This is because their knowledge is derived from long-term observational data maintained through an oral tradition. It is for this reason that the knowledge held by the community needs to be invoked in local classrooms. When we think of something or discover a new fact, we also think of all the interconnections between that fact and everything else. And so it is with their science: it is going to be connected to everything else. The local funds of knowledge in the community included the culture, attitudes, beliefs, concepts, ideas experiences and stories of the people in the coastal community. The local funds of knowledge are stored in the people’s lives, in their environment and their history. The local knowledge, wisdom and experience were valuable, appropriate and still relevant for people and can be called to teach relevant skills in school-based science. This knowledge base is a rich resource for teaching biology, environmental science and ecology.

There were identified barriers in the teaching and learning situation in coastal communities; academic, situational, and dispositional. The set of learning materials represents my attempt to delineate a preparation content covering how regular classrooms and schools should be designed to ensure all students have appropriate opportunities to learn effectively. This, of course, includes the many that manifest commonplace behavior, learning, and emotional problem. However, these learning materials are designed to address the academic barrier. Nonetheless, parallel to the development of the materials, an approach (culture-based, science literate, and coastal) as an educational strategy was also espoused to enrich the material in its delivery to the mainstream classroom. The materials represent my attempt to deliver learning to the local students to answer stated usual problems in their place: pollution, health, environmental protection, climate change mitigation, disaster risk reduction and preparedness and biodiversity. Relative to this, training, seminars, workshops are also recommended to address the said barriers.

This research suggests means and ways on how to respond to the question of how to support science teaching in rural and coastal settings and frames challenges to student learning as disconnects between community-based and school-based forms of science. This disconnect occurs when students do not see how the science in schools has value in or relates to their lived experiences and when local schools do not see how the lived experiences of learners have value in learning and doing science. I have presented here a case of what I call connected science, which uses real-world problems and often the finitude partner ships as contextual scaffolds to bridge these diverse funds of knowledge.

The study developed two important theoretical contributions. First a model on how to create culturally relevant community-based learning through: (a) mining local funds of knowledge from the community, (b) constructing a science literate learning strategy for coastal communities, (c) developing a tailor-fitted instructional material for coastal communities and (d) teaching culture-based, and context-based science in schools. The second contribution is the theory of Community Learning Exchange Valorization. This theory attempts to conglomerate conceptions and reasons about the meaning of ‘community’ funds of knowledge, and the way this knowledge can be valorized and be ‘given back’ to the community.

On a final note drawing on the assets of the community can help schools build citizens while infusing academic course work with meaning and relevance. Rather than diluting the school curriculum, community-based learning strategies increase the intensity of learning and the likelihood that young people will transfer knowledge and skills to new situations. By fostering student interest in their respective communities, these strategies sow the seeds of lifelong learning. When students see themselves as citizens, they take responsibility for what happens to their neighborhoods, communities, and country at large.

P-2238-04

Wunan Law and Human Identity through Connections with Country

J. Doring (1)
(1) Parthway, Broome WA, Australia

In the Kimberley region of North west Australia, much local knowledge is not found in the textbooks, but is part of the everyday work of people sharing a complex legal association with landscapes that weave together identity and country binding people to environments inherited in perpetuity. Wunan law remains defined by Wbian art, preserving the wisdom of silica crystals leached by weathering from sandstone through a long history that spans millennia of changing climates from estimates of 23,000 years past up to the present day; the film GWION documents Paddy Nyawarra repainting a sentinel Gwion figure standing guard at the junction of three Wunan districts in 1999. Wunan laws defining human identity through land contradicts the assumption that the nomadic aboriginal is of little value to offer modern science, in fact, and as published in Rock Art Research March 2014, Wunan living evidence of the longest continuous stable social system documented by the human hand.

Wunan law proscribes social identity as living connections to country so over time Gwion artists were motivated to portray human figures with unique extensions to their body, making specific social connections to local flora and fauna. Many ancient Wunan law songs about birds and animals of Wanjina and Gwion rock art say that young people will transfer knowledge and skills to new situations. By fostering student interest in their respective communities, these strategies sow the seeds of lifelong learning. When students see themselves as citizens, they take responsibility for what happens to their neighborhoods, communities, and country at large.

P-2238-05

Toponymy of an occupation early hunter gatherers in marine Quintero

C. Fuentevilla (1)
(1) Universidad Arcis, Santiago, Santiago, Chile
This is a presentation of the state of the art of research conducted in a series of explorations in the line of rocks from San Fuentes Lace up Pirate's Cove area, in the town of Quintero, Chile, between 2011 and 2013. It describes the finding of lithic evidence in five archaeological sites from perforations in the rocks as water toponomy signaling; based on the experience of discontinuous occupation of marine hunter–gatherers. As a result of continental settlement in the late Pleistocene and early Holocene, the lithic assemblages of the context generated conditions of survival, which according to weather representations, allowed the survival of anthropogenic Paleoindian presence. However, the last glacial interval was not an expression of melting, but neoglacialization. Therefore, while climate change was constant, it created new demands for adaptation in order to ensure the survival of hunter–gatherers. Therefore, the prehistoric lithic technology fitted the necessary mobility of the group. A synchrony between their social structure and technology in understanding their decisions, represented in a toponomy of lithic signs to identify water as a source of survival. Key Words: Hunter–gatherers, paleoenvironment, lithic toponomy, Paleoindian, climate change.

P-2238-06

Indigenous Knowledge as Local Response to Globalization and Climate Change in Nigeria/Africa

G. Nwaka (1)
(1) Abia State University, Uturu, Humanities and Social Sciences, Uturu, Abia State, Nigeria, Federal Republic of

As we consider the Post–2015 Development Agenda for Africa, indigenous knowledge may prove to be "the single largest untapped yet marginalized in the development enterprise". Critics of African development liken the current pattern of development in the continent to building a house from the roof down as "all the institutions are oriented towards trying to be acceptable to the foreign countries that have no firm connection to them, and whose indigenous institutions, even when oriented in the right direction, lack the necessary scaffolding to connect them to the new institutions". The modernization process contributes to this but suffers from the most disastrous consequences of climate change. While the industrialized and more affluent countries are rightly being called upon to take greater responsibility for the current global environmental and economic crises, Marshall Sahlins has rightly emphasized the need for all peoples "to indigenize the forces of globalization and turn them to their own ends", as the social organization of globalization depends largely on the responses developed at the local level. How can Africa engage with globalization, and cope more effectively with the worsening threats of flooding, droughts and other emergencies that result from extreme weather conditions?

For a long time African customs and traditions were misconceived as irrational and incompatible with the conventional strategies of development. In the context of modern global economic and ecological crises have exposed flaws in the Western neo-liberal model of development which is largely to blame for these problems, and for widening inequalities within and between nations. With the obvious underperformance of the Millennium Development Goals in Africa, there is now renewed interest in an alternative approach which emphasizes the cultural dimension of development and the potential of indigenous knowledge. This paper considers how indigenous knowledge and practice can be put to good use in support of good governance, agriculture and natural resource management, poverty alleviation, and the mitigation and adaptation to climate change. Although poverty may sometimes force people in the developing world to use resources un sustainably, recent research in colonial African societies have deeply entrenched ideas about environmental protection and sustainability since their livelihood depends largely on the land and on the stability of the ecosystem. They believe that land and other forms of nature are sacred, and are held in trust by the present day users on behalf of dead ancestors and future generations. Chief Nana Ofori Atta of colonial Ghana emphasized to a British official that "land belongs to a large family of which many are dead, a few a living, and countless hosts are yet unborn".

The paper argues that the indigenous knowledge movement is not only a useful and creative way to respond to globalization, it also has great potential for the mitigation and adaptation to climate change. While Africa cannot now contemplate the line of rocks from San Fuentes Lace up Pirate's Cove area, in the town of Quintero, Chile, between 2011 and 2013. It describes the finding of lithic evidence in five archaeological sites from perforations in the rocks as water toponomy signaling; based on the experience of discontinuous occupation of marine hunter–gatherers. As a result of continental settlement in the late Pleistocene and early Holocene, the lithic assemblages of the context generated conditions of survival, which according to weather representations, allowed the survival of anthropogenic Paleoindian presence. However, the last glacial interval was not an expression of melting, but neoglacialization. Therefore, while climate change was constant, it created new demands for adaptation in order to ensure the survival of hunter–gatherers. Therefore, the prehistoric lithic technology fitted the necessary mobility of the group. A synchrony between their social structure and technology in understanding their decisions, represented in a toponomy of lithic signs to identify water as a source of survival. Key Words: Hunter–gatherers, paleoenvironment, lithic toponomy, Paleoindian, climate change.

P-2238-07

Local Management of Andean Wetlands in Sajama National Park, Bolivia

PL. Pacheco Mollinedo (1); E. Villarroel (1); A. Domic (2); J. Capriles (3); C. Espinoza (1)
(1) Agua Sustentable, Climate Change Adaptation, la paz, Bolivia; (2) Universidad Mayor de San Andrés, Campus Universitario de Cota Cota, Herbario nacional de bolivia, La Paz, Bolivia; (3) Instituto de Alta Investigación, Campus de tarapacá, antofagasta 1520, casilla 6-d, Arica, Chile

Andean wetlands or bofedales are commonly used by indigenous communities for livestock production. Decisions regarding management of bofedales involve the active participation of local people and their social institutions. Consequently, any action addressing emerging challenges must be engaged in negotiation and agreement with local actors. This decision process requires an understanding of the local socio-economic and cultural dynamics, especially those related to land and natural resource management. In many Andean communities, the ayllu is the institution that governs decisions on regional land use. However, in the face of increasing challenges such as climate change and population growth, use of the ayllu has declined in the face of individual decision-making. Here we discuss how the Andean camelid herders of Sajama National Park in highland Bolivia rely on both the ayllu and family-level decision-making to manage their pastoral landscapes, including their bofedales. Using a rights mapping methodology, we describe how water and wetlands are managed, and determine which decisions are taken at the community level and which are made at the family level. We conclude that indigenous collective organization networks are still significant for managing the system at a regional scale and possibly determinant for mitigating risks associated with climate change on sensitive ecosystems such as bofedales.

Since the Spanish conquest in the 16th century, the world view of native peoples and indigenous peoples had to interact with the dominant sociopolitical systems of the colonial and later republican period (Schiffer 1992, Regal Sky 1994, Platt et al 2006). One important element of confrontation between these two visions was the form of land and natural resource management, collective vs individual. Indigenous communities adapted and developed a number of cultural and productive organizational strategies to cope with the new forms of domination, trying to maintain the logic and vision of the Andean territorial management strategies (Orlove 1977; Platt 1982; Spalding 1984).

One of the main strategies in the Andean world was access to the greatest possible number of ecological zones, which was a strategy to achieving food self-sufficiency and also an important risk management strategy in high Andean environments, especially for mitigating risks associated with climate change on sensitive ecosystems such as bofedales.
Indigenous knowledge for seasonal weather and climate forecasting across East Africa

M. Radeny (1); M. Nyasimi (1); J. Kinyangi (1); J. Recha (1); D. Mubiru (2); H. Hahoo (3); D. Ayal (4)

(1) ILRI, Centre for East Africa, Nairobi, Kenya; (2) NARO, Kawanda, Kampala, Uganda; (3) Sokole University, Agricultural engineering and land planning, Morogoro, Tanzania, United Republic of; (4) UNISA, Addis Ababa, Ethiopia

Advance knowledge of climate information is important in helping farmers make decisions about allocation of land and labor, to various agricultural enterprises. A clear understanding of this knowledge enhances their capacity to adapt to climate variability and climate change. Climate information coupled with agro-advisory services offers greater potential to manage climate-related risks in the face of increasing uncertainty. While progress has been made in provision of climate services for farmers, significant gaps still exist with regard to downscaling location-specific forecasts, reliability, timeliness and user-friendly climate information that effectively addresses the needs of farmers. Consequently, most farmers rely on indigenous knowledge (IK) for their seasonal forecasts, where locally observed variables and experiences are used to assess and predict the local weather conditions and particularly the onset of rains as it determines the sequence of many of the farm operations. However, IK experiences for climate forecasting are not considered to be passed on from one generation to the other through oral history and local expertise, creating a wide inter-generational gap between its custodians and the young generation.

This paper presents a synthesis of existing IK in weather forecasting across four sites in three East Africa countries – namely; Kenya, Tanzania and Ethiopia. Lushoto (Tanzania) and Halima and Rakai (Uganda). Across East Africa, small stock herders use various local indicators to predict weather patterns, especially the onset, magnitude and cessation of the rainy seasons. The indicators can be grouped into three main categories; meteorological traditional indicators, astronomical indicators and biological indicators. Meteorological indicators commonly used include the occurrence of heavy rainfall, high winds and thunderstorms in the occurrence of heavy rainfall, high winds and thunderstorms in the two days before the onset of rain. Biological indicators are further disaggregated into animal and plant indicators. A change in animal behavior at the onset of rains is believed to be triggered by aroma from volatile compounds that increase in intensity when changes occur in humidity. In Uganda, the sound from amphibians during day time and those of certain birds are used widely to estimate the likelihood of the onset of rain. In Tanzania, appearance of certain physiological stages of insect populations, such as thrips in the wetland indicates the likelihood of an above normal rainfall season. Plant indicators most frequently used in Uganda include the sprouting of young shoots of the mango tree and blossoming of coffee bushes. In Ethiopia and common plant indicators included flowering of venonia, pears, Albizia spp. and plums. Shedding of leaves of black nightshade also indicate the onset of rain.

We observe that farmers and herders were using these local indicators to make important agricultural production decisions including the timing of land preparation, dry planting, and grazing of seasonal crops. Farmers also use animal indicators to trigger the irrigation of crops to grow, agronomic practices to use, and labor allocation. In Borana, IK forecasts are used to plan livestock mobility and sharing of livestock amongst relatives to minimize losses during drought conditions. In Ethiopia and Tanzania, farmers considered IK climate forecasting a reliable source of climate information. They extend IK for forecasting of extreme events e.g. droughts and timing of the onset of rains. The paper presents a framework for integrating IK and scientific forecasting from the national meteorological agencies can improve the accuracy of climate forecasts for farmers in East Africa.

L. Zamorschikova (1)

(1) North-Eastern Federal University, Institut of modern languages and regional studies, Yakutsk, France

The North as a cultural–historical form of civilization is composed of socio-cultural communities of individuals with well–known and persistent traits and characteristics, such as language, culture, environment, economics and social opportunity. Geographical and climatic conditions in the North influence the formation of similar elements of the mental and linguistic identity of the peoples of the North. The common feature defining all northern communities is the deeply ecological aspects of their culture and recognition of a special relation with nature.

The research is aimed at study of northern world view through free association experiment’s database realized in indigenous communities. The associative verbal nets reveal the peculiarities of spiritual and material culture, ethnic stereotypes of behavior, traditional beliefs and specificity of ethnic world view. Mental and linguistic identity of the peoples of the north.

The world view is a major component of culture and contains all the essential elements of traditional and cultural knowledge which an individual, belonging to a particular culture, needs in order to adapt to both natural and social components of his/her surrounding environment. This is the reason, so to say, through which people see the world in which to act. The structure of the world view is shaped in the early stages of ethnogenesis, and remains largely immutable throughout the life of an ethnic group. It is the world view that forms the uniqueness of a particular culture and, hence, its carriers – the members of an ethnic group comprising a social community characterized by a specific cultural model which mediates the nature of their activity in the world.

The data of free association experiment (associative–verbal nets) in so far as they reflect unconscious layers of the mind, especially within the context of inter-cultural contact in a multicultural and multilingual environment, present interest not only for the investigation of a variety of scientific problems, but also of many issues of everyday life of indigenous peoples. In particular, and the relationship to the land are key elements in a seemingly fragile and yet tenacious Arctic indigenous identity.

There is high correlation between language retention and cultural identity of the peoples of the North. They live in close contact with the land, the sea, and the animals. Many indigenous Arctic peoples continue to live partial or total subsistence lifestyles, which is reflected in their languages, most obviously in their vocabularies, but...
also in the contents of their everyday stories, which often involve hunting, fishing, and encounters with animals (especially bears). While the links between language, culture and environment may not be obvious to outsiders, they are deeply embedded in the daily life of indigenous peoples (L.Grenoble).

Government policies in the sphere of national relations in the Republic of Sakha (Yakutia) place particular importance upon questions of vitality of small indigenous peoples' languages and cultures. The indigenous peoples of Yakutia, living in the inhospitable climate of the North, created unique modes of life and have interesting and instructive histories, traditions, and original cultures. Globalization and the pressure of mass culture endanger not only their languages but their traditional ways of life.

The researches of North-East Federal University of Yakutsk has been conducting psycholinguistic research on linguistic identities and indigenous peoples of Yakutia, the North, living on the territory of Yakutia. In this context, linguistic research plays a vital role in the efforts to preserve the ethnic languages and by extension cultures of the people living in the North of Russia (O. Evenki, Yukagirs) since language not only communicates, but also encodes essential aspects of cultures and fix their uniqueness for preserve and translate to the next generations.

### 2239 - Co-production of knowledge How to interact to produce climate adaptation research, between scientific communities and stakeholders, at local or international, also between North and South countries?

#### ORAL PRESENTATIONS

**K-2239-01**

Unpacking the co-production of knowledge in adaptation to climate change

S. Dessai (1); S. Beck (2); J. Porter (1); J. Van Der Sluijs (3)

(1) University of Leeds, Leeds, United Kingdom; (2) Helmholtz Centre for Environmental Research – UFZ, Leipzig, Germany; (3) University of Bergen, Centre for the study of the sciences and the humanities (svt), Bergen, Norway

The Intergovernmental Panel on Climate Change (IPCC) has been instrumental in raising political awareness of climate change at the global level, whilst the knowledge produced by the IPCC and other high level scientific programmes is seen as relevant it’s not always “usable” for decision-making at the local and regional level where adaptation to climate change is crucial. Despite advances in climate science and adaptation policy, critical understandings of which approaches can most effectively harness science and technology for long-term sustainable adaptation is still lacking. “Usability” of science cannot be taken for granted. In order to fill the gap between the supply of scientific findings and its demand at different levels of decision-making, co-production has become a key concept guiding major international research initiatives. “Co-production” has a myriad of meanings, some practical-organizational oriented others social-philosophical. This talk aims to unpack how much, what and to what extent, the concept of co-production can inform scholarly debates and practical exercises on adaptation to an uncertain future climate. The talk is informed by a recent international workshop on the topic and empirical work conducted in the United Kingdom on the construction and use of climate change projections in long-term adaptation decision-making.

**K-2239-02**

Climate change adaptation: towards a new geography of knowledge?

C. Buffet (1); S. Huq (2)

(1) Centre Alexandre Koyré (EHESS/CNRS), Paris, France; (2) International Center for Climate Change and Development (ICCCAD), Dhaka, Bangladesh

Facing critics and distrusts towards a “Northern Science” accused to mainly follow Northern interests (Lahsen, 2004), IPCC strove to better include Southern Scientists in report production (Dahan, 2008). However, as noted in its fifth assessment report, there remains a North-South inequality in research production and access, in spite of a raising involvement of Southern Scientists. This discrepancy is both rooted in research funding and limits of capacity (Burkett, et al., 2014).

The issue is thus particularly sharp for Least Developed Countries (LDCs), who are both the less responsible, the most affected and the less in capacity to forecast and respond to the impacts of climate change. In parallel, this perspective led to a progressive construction of Southern capacities, both within UNFCCC (Local expert group); Ministries (focal points to implement NAPAs) and among civil society (academics, think tanks, NGOs). Beyond North-South cooperation for technological transfers and impact model regionalisation, the emergence of “bottom-up” approaches since 15 years, in particular «Community-based adapatations», deeply changed adaptation framing: this approach involves humanities and social sciences, jointly with the population and authorities actually living the models and striving to adapt.

Through examples from Bangladesh, one of the “hot spots” of adaptation, this talk aims at underlining the current development of Southern capacities that contribute to a “new geography of knowledge”.

**O-2239-01**

Developing robust adaptation strategies: the importance of embodied knowledge, local knowledge and place attachment

R. Lidskog (1); P. Castro (2)

(1) Örebro University, Environmental sociology section, Örebro, Sweden; (2) ISCTE-IUL, social psychology, Lisbon, Portugal

This presentation focuses on the importance of including local knowledge in developing strategies for climate change adaptation. The importance of this focus is that the current intertwining of, and reliance on, legal-institutional and scientific expertise in environmental policy-making often leaves little room for inputs from actors on local levels, although these many times possess detailed and relevant knowledge. Regarding climate change adaptation, research in both rural and coastal areas has recently shown how meaning and identity bonds to places (expressed in place memories, norms, narratives, identities and motives) indeed matter for adaptation. Whereas a number of studies have been conducted around place (mainly in terms of place identity, sense of place and place attachment) one thread seems however to be conspicuously missing: that of place knowledge proper. A reason for this may be the epistemic division of labor in our societies where local knowledge is re-defined as a subjective and cultural construct, contrasting it with the “real”, objective and universal knowledge provided by scientific expertise. At the same time there is an increased recognition both in science and society that environmental problems require elements of local knowledge for their solution; contextually generated knowledge about local circumstances and local practices are relevant because global risks always have local and place-specific implications. Local knowledge is bond to place through its relation to living; people live in specific places and gain embodied knowledge (not least in the form of routines and habits) about how things are and work in their local surroundings. This kind of relations to place developed and supported through knowledge and their implications for addressing climate change adaptation are discussed by using findings.
from two different studies in rural areas; i) a focus group study of farmers (N = 50) conducted in Natura 2000 areas of importance for climate change adaptation; ii) a study of professional expertise (N = 20) that try to persuade forest owners to consider climate change in their forest practices and a study of 20 forest owners (N = 20) in forest teams that are prognosticated to be heavily affected by climate change. Through these empirical studies, it is possible to gain knowledge both on how professional expertise try to persuade key actors on local level and on how farmers and forest owners acknowledge their situation as well as evaluate and handle knowledge claims for changed action provided by expertise. The analysis finds a number of strategies through which farmers and forest owners evaluate and negotiate expert claims, resulting in partial appropriation and partial rejection of them. By reclaiming their local knowledge, accentuating how this knowledge binds them to particular places and expressing their embodied and (em)placed knowledge, they re-signify and re-contextualise the original expert advice.

A central finding of this study is that it is not knowledge as a product or property, but as practice that matters when addressing issues of local adaptation to a changed climate. The reason for this is that knowledge is not distributed and exchanged as a product or property, but is instead actively appropriated and thereby also transformed. In this dynamic process, different kinds of epistemic and ontological boundaries are crossed and new meaning is produced. Knowledge and how knowledge is developed and appropriated in different institutional and spatial settings – the knowers and his/her knowing are put at the centre, and these practices constitute an important condition for developing adaptive strategies and measures to be implemented locally.

O-2239-02

Blending local and scientific knowledge to support innovative action by community-based institutions to adapt to global change

R. Reid (1)

(1) Colorado State University, Dept. of Ecosystem Science and Sustainability, Fort Collins, United States of America

Today, scientists, government officials, community members and non-profits work together to blend different knowledges and apply this joint understanding to real world problems and change in local and regional social-ecological systems around the world. This transdisciplinary work often starts with explorations of different ways of knowing and what constitutes ‘truth’ in the cultures of research, science and society. How knowledge is developed and appropriated in different institutional and spatial settings – the knowers and his/her knowing are put at the centre, and these practices constitute an important condition for developing adaptive strategies and measures to be implemented locally.

At the community level, innovative institutions are arising to improve the sustainability of local systems, sometimes strengthened by the decentralization and devolution of power in different settings globally. These institutions are often led by local community members collaborating with diverse stakeholders at different scales. This is creating a revolution in the ability of local actors to respond to global and climate change in local land-, lake- and sea-scapes.

Here, I describe some principles and examples of the models that different transdisciplinary teams are using around the world to bring together diverse knowledges and create innovative solutions to global change problems. These include different practical methods like workshops to brainstorm research questions and methods, practitioner or landowner-led research projects, integrated projects, co-producing knowledge projects. This paper focuses on how to blend local and scientific knowledge, based on case studies. I will conclude with a description of future directions for co-production and the potential for co-produced knowledge to be a catalyst for social change when working on global change issues.

O-2239-03

Building Institutional Capacity for Climate Change Policy: The Chilean Experience in Co-producing knowledge for acting

P. Calfucoy (1)

(1) MAPS Programme, MAPS Chile, Santiago, Chile

Chile, as part of its climate change policy, assumed in 2010 the challenge of generating evidence nationwide to project long-term scenarios and options for mitigation of greenhouse gases (GHGs), in order to support its position in the international negotiations on issues of climate change and simultaneously, evaluate alternatives that contribute to a low carbon development for the country. This effort, was materialized in MAPS – Chile, a project of South-South cooperation with South Africa, Brazil, Colombia and Peru, in which a process of scientific research was integrated with multi stakeholder participation to estimate the baseline emissions of the country and evaluate mitigation actions and scenarios that might contribute to a low carbon development path.

MAPS Chile integrated a logic of co-production of knowledge with the participation of national scientist, policy makers and experts from the academia, the public sector and NGO’s under the coordination and policy guidance of the State of Chile. The project was successful in giving its results were used to define the Contribution proposal to be presented at COP 21.

From the perspective of sociology of science and technology, the analysis of this experience seeks to deepen in the understanding of mechanisms and methodologies for the formulation of policies on climate change in developing countries. Centered on the concept of Co-production (Jasenof, 2010), the analysis focuses on the governance structure of the project, the strategic decisions, and the methodology that articulated the interaction between institutions and key parameters that were participated, to finally identify the main strengths and weaknesses to inform climate change policy in developing countries.

The methodological approach for the study was qualitative. I apply content analysis using secondary data together with discourse analysis from semi-structured interviews that allowed knowing the perceptions and opinions of the participants in the project.

Among the main results of the study, I highlight:

i) The valuation of the participants of the process of opening the black box of modeling. The co-production of knowledge was understood as the exercise of defining between the scientist and the stakeholders the main assumptions, evaluating in conjunction the quality and availability information and making explicit the scope and limitations of the methodology used. According to interviewees, allowed a better understanding for non-experts of the constraints and opportunities for sectorial and macroeconomic modeling. Additionally, this process provided credibility and validity to the results, while recognizing the levels of uncertainty intrinsic to this type of research. The methodology generated procedural legitimacy to the results. The agreements thorough the participation process about the key parameters that will be used in the modeling process, facilitate the recognition of the results. The project successfully validate their interim decisions and to rest the legitimacy and validity of their results in their agreements.

ii) The valuation of the participants regarding integrating local knowledge: The process of building the results with the participation of local researchers and experts contributed to a better understanding of the micro dynamics of the sectors, a better understanding of the country’s productive structure and the constraints, opportunities and the technological and feasibility constraints. In particular, the discussion about the penetration rates of potential mitigation actions are valued as an exercise done by the incumbent political system.

iii) The valuation of strengthening decision-making in the public sphere by enriching the understanding of the causes of the problems, their dynamics and implications. The exercise of co-production facilitated the socialization
of complex results because of the opportunity of learning generally. It includes the opportunity to learn from the dynamics of other sectors, the opportunity to visualize areas of complementarity with other colleagues and topics. The opportunity to learn from methodological tools.

E-2239-04

Strengthening the science-policy interface for climate change adaptation at the regional level

H. Dannevig (1)
(1) Western Norway Research Institute, Sogndal, Norway

Despite a vast amount of scientific knowledge, society is unable to properly address the pressing issues of adapting to climate change. Planned adaptation, or adaptation planning, is a policy issue which owns its existence to climate science and it is comprehensible only through abstract scientific models. Adaptation planning therefore involves translations of these, as well as assessments of risk and uncertainty, and in order to support these processes, various institutional arrangements have been developed (Hoppe & Wesselink 2014). The Intergovernmental Panel of Climate Change (IPCC) is itself an example of this. While there has been widely recognized that planned adaptation is a multi-level governance issue (Keskitalo 2010), research on adaptation governance has tended to focus either on the local or the national governance levels: while regional adaptation governance has seen strong attention (Hanssen et al. 2013). The local level of government on the other hand has been deemed a key actor in the governance of adaptation. In the case of Norway, as in most western industrialized countries, there is a strong belief that the local level of governance has the key role in this respect. But despite large efforts from national government agencies and the research community in supplying local government with tailor-made and downscalled climate change projections and comprehensive guidelines, climate change adaptation is still lacking. As a response to the mixed success with national and local adaptation integration, there has been called for stronger involvement of the national level (Amundsen et al. 2010), stronger coordination between levels and across sectors (Hanssen et al. 2013) and a strengthening of the knowledge provision through various boundary arrangements that links experts and knowledge users for the purpose of production of knowledge for policy-making (Corfee-Morlot et al. 2011). This paper contributes to existing research by examining how regional government in Norway has interpreted its role in coordinating climate change adaptation in spatial planning policy networks. Drawing on research from research on boundary work, it critically assesses how regional government in Western Norway configured boundary arrangements between scientific and policy communities. This is addressed through an analytical focus on the nature and extent of boundary work, i.e. the translation, mediation and communication (Cash et al. 2003), that regional government actors engage in through their application of policy coordination instruments. Empirically, the research involves a review of ongoing spatial planning processes in six municipalities from four counties in Western Norway. The study concludes that even though adaptation is not treated as a salient issue in national policies, the regional adaptation governance coordination is creating a hybrid management space that aid mediation between the local users knowledge and expert adaptation knowledge, and thus hold the potential for better local level adaptation planning.


Current adaptation practices: case studies in France, Portugal and Greece

A. Baills (1); A. Lillebe (2); T. Paramana (3); C. Parrod (4); S. Luis (5); A. Stepanian (6); G. Co Lezannt (7)

(1) BRGM, ORLEANS, France; (2) University of Aveiro, Department of biology & cesam, Aveiro, Portugal; (3) National and Kapodistrian University of Athens, Faculty of Geology and Geoenvironment, Laboratory of physical geography, Athens, Greece; (4) Acteon, Colmar, France; (5) ISCTE-Instituto Universitário de Lisboa, Libon, Portugal; (6) BRGM, Marseille, France; (7) BRGM / CNRS, BRGM-DRP / R3C / CNRS-LGP (UMR-8591), Orleans, France.

The warming of the climate system is now unequivocal and strong warming of air temperature and an acceleration of sea-level rise is projected in the Mediterranean regions of Europe (IPCC, 2013). At the same time, adaptation measures are being set up to cope with the effects of both climate change and the社会. To which extent do these adaptation policies actually meet the challenge posed by future climate change? To answer this question, a detailed understanding of the current practices of adaptation is needed as well as a comprehensive view of how this adaptation is perceived by its main actors. However, such information is lacking at present. Therefore, a literature review has been combined with 8 semi-structured interviews conducted on three coastal sites in France, Portugal and Greece, where different approaches toward risk prevention and adaptation to climate change are in place. In order to identify gaps between the theoretical framework and the practical situation at local scale, the interviewees have been asked with their general knowledge of climate change (present and future changes) and on the existing and desirable adaptation policies / measures.

The interviews and the literature review underline similarities and differences in the countries approaches, organization and awareness. France, Portugal and Greece have different level of national policies development regarding climate adaptation and climate change awareness can be influenced by local in situ situations. But even when climate change and climate adaptation are subjects of concern, a lack of concrete "local" implementation is pointed out by stakeholders, as very few adaptation measures have been implemented yet. Indeed, climate adaptation is recognized as a traversal issue by the interviewees. Hence, related policies have to fit within already developed and complex sectorial legal frameworks related to water management, risk prevention, health, environment and so forth.

Literature review and stakeholders interviews both highlight the time horizon issue related to the difference between climate change and political mandate’s time horizons. They also stress a gap between science and non-scientific local stakeholders for expected knowledge and actions, and this gap tends to be reinforced by the complexity of the legal framework for climate adaptation. This complexity is particularly pointed out by interviewees acting at regional and local scales in France, which is the country where adaptation to climate change has been the most considered in various regional sectorial policies.

To overcome these specific barriers to adaptation, the interviewees suggested that one first step should be the creation of interest groups at regional level, gathering all concerned actors and a complementary lead could be to adopt laws at the national level to incite local authorities to act together with regional actors. The next step would then be to design adaptation measures and to assess their
efficiency.

This work has received funds from the ADAPT-MED project (CIRCLE2-MED).

P-2239-02

Vulnerability as Transformation: Photovoice Adaptation in the Philippines

Y. Cai (1)

(1) University of the Philippines, Diliman, Women and Development Studies, Quezon City, Philippines

In this participatory action research (PAR), the author explored vulnerability in the framework of transformative adaptation through the application of Photovoice in three disadvantaged urban communities in the Philippines. Few planning scholars and practitioners have developed systemic adaptation models and tools to address climate-related risks and vulnerability from the local perspective. This research explores disaster risks and capacities for adaptation through the lens of a marginalized population and emphasizes vulnerability as the transformational factor for innovative adaptation. The Philippines has faced frequent and devastating typhoons and raging floods, especially in the past few years, which have killed hundreds and destroyed millions of homes and businesses. Climate risks as well as adaptive capacities of vulnerable populations, such as women, have been overlooked or even distorted. During a one-year period, this research project provides disadvantaged community members with digital cameras (through smart phones) and fundamental training, facilitates them to cultivate narratives and social media networks, and encourages communities to develop action mechanisms for disaster preparedness, mitigation, and recovery. Through an empowering Photovoice approach, it reveals climate risks and capacity building of a disadvantaged population in metropolitan Manila and Cebu City. Disadvantaged participants facing frequent climate hazards embody resilience via flexible and entrepreneurial strategies. It demonstrates the missing perspective of the current climate adaptation agenda: vulnerability can transform creative and collaborative adaptability.

P-2239-03

Evaluating the Resilience of Traditional and Non-Traditional Family Farming Systems in Mountain Areas of Peru

E. Chavez (1) ; G. Quartieri (2) ; O. Madalengoitia, (3) ; E. Michaud (1)

(1) National University of San Marcos, Faculty of Veterinary Medicine, OIKOs Association., Lima, Peru; (2) IUSR http://www.unisrita.it, PHYSICS, SAN PIETRO INFINE (Caserta), Italy; (3) OIKOs, Lima, Peru

The mountain agricultural systems of Peru could help to improve the resilience facing the climate change. These systems, mostly of them kept in familiar farming milieu provides ecosystem services (like water basin conservation) and with a low carbon impact, have potential to improve mountain resilience, conserve the biodiversity, and improve food security. The presentation is focused on comparing the hydro–management, food security and energy consumption of two types of production systems. One based in the use of petrol derivate and «modern» techniques and another based in the recycle of products and with the use of traditional knowledge.

The central Andean region (covering Peru, Ecuador and Bolivia), is one of the world’s centers of origin and domestication of animals and plants. In this region the domestication processes innovated the use of traditional and particular agricultural system by means of techniques, experiences and improvement processes.

These systems are part of our bio–cultural history that has been created by people in thousands of years as a result of the interaction of Andean people and its diverse environment. These systems, mostly of them kept in familiar farming milieu, have an enormous potential to improve mountain resilience, conserve the biodiversity, and improve food security. However, there are many drivers (including the climate change and wrong federal management) that jeopardize the continuity of this farming systems.

G. Cloutier (1) ; J. Glowacki (2)

(1) Université Laval, École supérieure d’aménagement du territoire et de développement régional, Québec, Québec, Canada; (2) Université Laval, Québec, QC, France

Adapting local areas to climate change is a wicked problem for local policy makers, as it involves a continuous struggle between the collaborative efforts of multiple stakeholders, the changing of our mindsets, the lack of resources and the difficulty in deciding between alternative planning scenarios. Even if the percentage of local governments involved in one way or another in adaptation planning is high, most initiatives, such as leaving the drawing board, can be attributed to the recent emergence of this concern. As well, the research conducted and the tools developed so far by researchers have little application that could help practitioners with their work on the interface between the various climatic impacts and their practices.

Also, decision makers involve, more than ever before, a variety of stakeholders in the decision-making process, following, in that sense, the collaborative planning prescriptions: citizen panels, public hearings, audits, charrettes, etc. contribute to reinforce public participation in local governance. Thus, the participation possibilities, support, in return, the legitimacy, validity and sustainability of decisions taken. Despite this, development targets and public policies are not always consistent with local contexts and local initiatives. Gaps between theoretical objectives and daily life contribute to the shifting of climate governance outside of the institutional frame of action. This is true not only for climate change: the whole urban political space is moving outside of the traditional frame of action.

The discussion and reflection on how to act and adapt the local space to climate change take place on different grounds and through new modes of collaboration, which will be examined through the analysis of the presented case studies. In developing countries and in cities of the developed world, non-governmental organizations, regional governments or other development-based associations draw from and modify existing modes of governance in order to carry out climate governance experiments. Such experiments take form independently from national and international programs, they cross scales and juridictional boundaries and their goal is to contribute to the local community response to climate change. These efforts take inspiration from existing governance patterns and improve them. They offer local actors a possibility to coordinate and harmonize between different types of of climate governance, particularly in the recycling of available resources without depending on public policies and intervention.

Local adaptation experiments are a way to explore original and innovative practices. Although experimental work has been carried out on the analysis of current practices and what they can teach us about the mainstreaming of this process. This presentation will analyze two local adaptation experiments in Quebec, Canada, which seek to adapt to increasing flood risk and the urban heat island effect.

How do such experiments take place? What data, expertise and financial resources are mobilized? What kind of institutional, organizational and economical contexts give way to these experiments? Based on preliminary results, this communication analyses the context and implementation of the two local adaptation experiments.
ABSTRACT BOOK
International Scientific Conference     7-10 JULY 2015    PARIS, FRANCE

B. Grambow (1) ; E. Lorant (2) ; Y. Lagadeuc (2)
(1) Mines Nantes, Université Nantes, CNRS–IN2P3, SUBATECH, Nantes, France; (2) Université Rennes I, Rennes, France

Orienting research and educational programs to tackle society’s major challenges, the New French federal University Bretagne Loire (UBL) is proposing to create the first International Sustainability Center. ISC in France as a high visible cornerstone of its transdisciplinary IDEX Initiative UBL+, focused on ocean/land/food/health society. It is our belief that the proposed approach could well be labeled “Future Earth” program in design & co-production of scientific knowledge on global sustainability.

UBL represents a very large territory of the size of Ireland with 27380 people working in research, 225000 students in higher education, and five laboratories of excellence in transdisciplinary studies (Ocean, Immunology, Nuclear Medicine, ICT and Mathematics), hosting 3 OSU and 4 Zones atelier, smart specialization fields in the area of sustainable agriculture, ocean and renewable energy. As knowledge is the currency in current, oriented research and education systems to address global environmental change or global sustainability, UBL aims with the Idex proposition to forge a new type of innovation-oriented university oriented knowledge area, of which ISC is a central part, increasing impact of leading edge research, cross scale system observation, learning, demonstration and exchange, accounting for the interrelationship between world oceans, global environmental change and climate, and environmental (soil, water, air), agricultural, urban, health and societal changes in our coastal regions. The goal is to foster participatory and international exchange between scientists, students and civil society, providing for scientific excellence in transdisciplinary studies of very complex global long-term systems, developing new pedagogical methods for transdisciplinary and international culture. Groundbreaking transdisciplinary science includes the need of opening up scientific disciplines to other ones (including numeric and social sciences), to other systems of thinking, and other stakeholders, ensuring problem framing, research definition and a plurality of issues on issues in sustainable development.

Inspired by and in collaboration with the Julie Ann Wrigley Global Institute of Sustainability (GiOS) of Arizona State University, the ICS shall become a Center for international meetings, exchange, research and education, focused on the link between transdisciplinary focus areas (oceans, land–sea interfaces and societies in transition; sustainably constructing food of future...) and the notion of sustainability. At the image of the global challenges to be addressed, with the macrobiotic strong and at the center “without walls” will be the entire regional interconnected territory, to offer an exceptional demonstrator in, for example, the major challenges linked to the land–sea continuum, the transitions to a sustainable urban planet, the question of food sustainability and health, digital transition and culture etc., assuring effective linkage between social challenges, transdisciplinary focus areas and territorial development.

The buildup of the ISC will start from partnerships already in place with transdisciplinary organizations (ASU, the University of Colorado, Anglia Ruskin University, and French Guyana, University of California, U Laval etc.)). The “Future Earth” program provides an appropriate frame for fully integrating the global mission in the ISC orientations, with contributions by civil society, including NGO, (“co–production of knowledge”) to the research process (participative investigations) concerning issues that have a major impact on society (e.g. integrated management of a coastal zone or center). A typical example for the importance of “Future Earth” program is in discussion between UBL and ASU/GiOS: the question is how to transition to a future that will be driven by the dynamics of urbanization. The InCAS and other mechanisms will be critical for building the international network and developing the science to develop the world’s best program in urban sustainability within Future Earth. Another “demonstration project” could be an observatory (without walls) able to assess long term trends in local and regional scale disruption to the provision of basic services. The main focus of the paper is on describing the practices of low-income urban residents in responding to climate–related shocks and stresses, placing these in a particular political context, and drawing lessons for urban policies in Bangladesh and elsewhere. A wide range of specific adaptation–related actions can be identified and these can be grouped into three main categories – individual, communal and institutional. The study examines the extent to which institutional actions are merely “copying” – or whether they create the conditions and institutional mechanisms that can strengthen their own long-term resilience. Similarly, it examines the extent to which individual and communal responses are merely “coping” and this approach can generate wider political change that strengthens the position of marginalized groups in the city.

The vulnerability of individuals, communities and cities to climate variability and change is an outcome of the interaction between an external threat or hazard and the internal characteristics of the environment and the individual, communal and institutional responses to these. The analysis contributes to an understanding of the dynamics of climate change impacts and responses in rapidly growing urban centres in Bangladesh, and to the relationship between urbanization, poverty and climate risk throughout Africa, Asia and Latin America. More specifically, however, it examines the potential for actions taken at the household and community level in urban areas to go beyond offering short-term “coping” solutions in response to specific events, resulting instead in more transformational changes that address the underlying
Exploring the preconditions for transformative change in the context of climate impacts and adaptation

G. Hovelsrud (1)
(1) University of Nordland, Faculty of social sciences, Bodø, Norway

While climate change is projected to substantially influence primary industries in the northern regions, climate change is not perceived to be an immediate concern when compared to outmigration, jobs, and the social and economic viability of municipalities (Hovelsrud et al. 2010). The apparent disconnect between the abundance of scientific knowledge about climate change, the overwhelming evidence that such changes are caused by human action and the general societal response and political commitment to deal with the changes (Hulme 2009, Jasanoff 2010; Szerszynski and Urry 2010). And mainstream political science and governance theories fail to explain why people and institutions do not act on climate change (O’Riordan & Jordan 1999).

In this presentation we draw on a broad range of adaptation studies focusing on the preconditions for transformative processes. One of our findings inspiring this study is that the perceptions of high resilience towards climate risks are expressed in the narrative ‘we always handle hardship’, reflecting deep seated perceptions of resilience, linked to high variability in resources, climate and socio-economic conditions. This phenomenon has by others been attributed to different understandings and interpretations of reality between groups of people or individuals. If climate change is not perceived sufficiently salient to warrant action, resilience may decrease and societal transformation become less possible. It is a major challenge that the climate change message and the need for societal change do not resonate well with many parts of society, combined with the findings that adaptation is not likely to be perceived as a priority by many measures (Dannevig et al. 2013, Tøsse 2012). On the other hand adaptation is taking place and has been associated with extreme events, observations of change, engaged officials and contact with researchers, which is reflected in the finding that society needs to better understand how climate change will affect them directly (Dannevig et al. 2013). How climate change knowledge is co-produced by science and policy we argue will be filtered through current perceptions and values, influencing their potential for transformative responses.

Perceptions of risks and the need to act on the basis of scientific knowledge hinge on whether scientific knowledge is viewed as salient, credible and legitimate (Cash et al. 2003) and on the individuals’ risk perception, resilience, values and livelihood (O’Brien & Wolch 2010, O’Riordan & Jordan 1999). The presentation will investigate the interplay between the local and national levels in providing salience to the climate change issue. We surmise that perceptions of risk have a bearing on how people and institutions contribute to climate change. This phenomenon has by others been attributed to different understandings and interpretations of reality between groups of people or individuals. If climate change is not perceived sufficiently salient to warrant action, resilience may decrease and societal transformation become less possible. It is a major challenge that the climate change message and the need for societal change do not resonate well with many parts of society, combined with the findings that adaptation is not likely to be perceived as a priority by many measures (Dannevig et al. 2013, Tøsse 2012). On the other hand adaptation is taking place and has been associated with extreme events, observations of change, engaged officials and contact with researchers, which is reflected in the finding that society needs to better understand how climate change will affect them directly (Dannevig et al. 2013). How climate change knowledge is co-produced by science and policy we argue will be filtered through current perceptions and values, influencing their potential for transformative responses.


Conclusively, the presentation will investigate the interplay between the local and national levels in providing salience to the climate change issue. We surmise that perceptions of risk have a bearing on how people and institutions contribute to climate change. This phenomenon has by others been attributed to different understandings and interpretations of reality between groups of people or individuals. If climate change is not perceived sufficiently salient to warrant action, resilience may decrease and societal transformation become less possible. It is a major challenge that the climate change message and the need for societal change do not resonate well with many parts of society, combined with the findings that adaptation is not likely to be perceived as a priority by many measures (Dannevig et al. 2013, Tøsse 2012). On the other hand adaptation is taking place and has been associated with extreme events, observations of change, engaged officials and contact with researchers, which is reflected in the finding that society needs to better understand how climate change will affect them directly (Dannevig et al. 2013). How climate change knowledge is co-produced by science and policy we argue will be filtered through current perceptions and values, influencing their potential for transformative responses.

Processes for self-determined transformative adaptation: The learning journeys of small scale farmers in the arid west of South Africa

B. Koelle (1); N. Oettle (2)
(1) Indigo development and change, Nieuwoudtvilee, South Africa; (2) Environmental Monitoring Group, Rural Programme, Nieuwoudtvilee, South Africa

A group of small–scale rooibos tea farmers embarked on a transformative adaptation journey more than 15 years ago by defining their community vision. This community is situated in the Northern Cape Province in South Africa and is severely affected by climate variability and change.

Today significant changes can be seen on an individual and communal level. This paper explores the aspects of the learning journey, using the results of qualitative interviews that have been conducted in the course of the past 15 years with various community members. Three key areas are examined: drivers of transformative processes on the personal and communal level, the role of experiential learning in transformative adaptation processes and ways of facilitating transformative adaptation processes.

At the start of the learning journey the Suid Bokkeveld community was socially and politically disenfranchised and economically marginalised. A participatory process facilitated by two local NGOs supported locally driven action research processes, the establishment and organisational development of a local trading co-operative owned by the farmers themselves. Embedded in these processes were opportunities for personal transformative learning specifically focusing on women within the Suid Bokkeveld community.

The paper explores enabling factors for communal and transformative adaptation in local communities, including sharing knowledge and insights with other communities, stimulating personal development and learning, supporting action research processes to develop adaptation strategies drawing on different types of knowledge (scientific and local knowledge alike). Participatory and experiential learning processes have been a key component and included participatory monitoring of livestock exposure to extreme heat stress, monitoring of water resources on farm level and local level weather monitoring. These processes carefully examined the impact and possible responses to climate change. It is important to plan ahead and be prepared for these possible shocks.

Using the transformative journey of the Suid Bokkeveld community as an example, approaches and tools for facilitating transformative learning are discussed. These approaches include facilitation of the articulation of a collective vision for effective adaptive responses, communication of climate information on the local level, ownership of learning processes by vulnerable communities and ways of facilitating reflective learning processes for transformative adaptation.

Model Forests and Open Collaborative Science: empowering stakeholders to adopt transformative adaptation practices

J. Lorenzo (1)
(1) CATIE–Tropical Agricultural Research and Higher Education Centre, Turrialba, Cartago, Costa Rica

This presentation is related to an ongoing project which is being implemented in two Model Forests of Latin America (in Costa Rica and Colombia). Model Forests are social initiatives which aim at improving governance and the sustainable management of natural resources within forest–rich territories (www.bosquesmodelo.net). Through an Open Collaborative Science (OCS) approach, the project pursues several objectives, including fostering participation and “citizen science” as well as improving
Addressing the research evidence needs for evidence-informed city resilience planning: Insights from Shimla city, India

J. Patra (1)
(1) Shimla Municipal Corporation, Climate Change Resilience, Shimla, Himachal Pradesh, India

Cities, the engines of economic growth and centres of innovation, are at greater risk of climate-induced changes. In a rapidly urbanizing India, key urban functionalities and infrastructure facilities are highly exposed to climate-related hazards and extremes. Two recent natural hazards in India, the Kashmir Floods (September 2014) and the Cyclone Hudhud (October, 2014) have highlighted how urban centers are witnessing a new regime of disaster and climate risk. Urban development is one of the key priorities of India’s government and the new initiative of 100 Smart Cities is a step in that direction. Climate-resilient urban development strategies are the core of this initiative. But one of the key challenges that policy makers, city authorities, planners and investors face is with regard to the availability to robust, reliable and relevant climate risk information at the city level. Although city level climate risk assessments are being undertaken by many scientific and research organizations, most of these information hasn’t been able to address the needs of city authorities and planners. How do we address these gaps in evidence-informed city resilience planning in a developing country context? Based on a systematic analysis of research evidence needs of city-level stakeholders in the capital city of Shimla in the climate-sensitive Indian Himalayas, including city authorities, this paper highlights a series of barriers, individual and institutional, that result in such gaps. It also highlights some of the opportunities through which the science and research communities could better understand and address the information needs of the policy makers and urban practitioners. More importantly, it demonstrates how such a city-level institutional system could open up new windows of opportunity to mobilise partnerships and resources for city resilience planning and implementation.

P-2239-11
Our common future, our common Global. Assessing Sustainability of local production systems: A proposal based on socio-ecological resilience and collaboration

RA. Seiler (1); MB. Wehbe (2); A. Vianco, (3); A. Mendoza (3); A. Baronio (3); A. Tonolli (4)
(1) Agrometeorology, Agriculture, Rio Cuarto, Argentina; (2) Economic Science, Economy, Rio Cuarto, Cordoba, Argentina; (3) Decision Sciences, Economy, Rio Cuarto, Cordoba, Argentina; (4) Agricultural engineering, Engineering, Mendoza, Argentina

Sustainability and resilience are key conditions for reaching a balanced functioning of socio-ecological systems, facing internal conditions and external shocks like those expected from climate change. However, there is no agreement on how to get a good measure for both concepts to allow for managing local production systems. As result of a two-year research a methodology for assessing sustainability was developed based on a collaborative process between science, policy and civil society to improve resilience, and therefore sustainability of local production systems according to the internal conditions to the system and the impacts of climate change and other global environmental changes as well.

The presented work is a joint contribution from an interdisciplinary research group from seven universities in the Centre-West of Argentina, and summarizes the analytical and methodological procedure to assess sustainability, based on the concept of resilience of socio-ecological systems. The four dimensions of the sustainability (ecological, economic, social and institutional) and their relationships are organized in a graphic tool. Matrix of the Aggregated Demands from each dimension to the other dimensions, and on the other, it shows the actual contributions to Human Wellbeing. Within the matrix, a number of components (e.g. water, soil, air, biodiversity, for the ecological dimension) need to be defined according to pre-established criteria for each of the dimensions. These components, expressed through one or more indicators (e.g. for ‘water’, indicators of quality, quantity and source would be needed) are to be related to the rest of components in the Matrix aiming at identifying synergies and trade-offs.

The components in the Matrix are not fixed but they depend on the characteristics of the production system or the region under analysis. The Principal Diagonal of the Matrix tells on the state of the system or the baseline for each dimension through the set of components under the same stated criteria. The rest of the Matrix establishes relationships among dimensions. As a way of exemplification, it is possible to think about the demand of a production system in terms of the availability of particular natural resources to develop the production process. The existence and specificities of natural resources spatially distributed determine not only the characteristics of an ecosystem but also the potential of the production system to develop, as well as the limits to such a development. The same methodology applies for all the relationships among dimensions.

Finally, the sustainability indicator to be constructed is a relative measure to its potential value and indicates the current position of the system in terms of the desired state. The inter-temporal and regular application of the methodology will determine an accurate evaluation of a system’s dynamic towards sustainability.

P-2239-12
Climate Change Research and Communication: Exploring potential connections

DL. Taina (1)
(1) State University of Campinas, Campinas, Brazil

In face of the delicate moment in which we live through the effects of climatic alterations and the intensification of extreme phenomena, the circulation of information about climatic changes is becoming increasingly important. How can we think about the communication of climatic changes as a potent and effective movement to provoke broad reflections on the situation? In our research group at the State University of Campinas, Brazil, we participate in the scientific research of climate change, as well as study communication proper, combining to create an important reflection on the potential of knowledge in connection with different areas, such as natural sciences, political science, sociology, philosophy, arts and much more, being an interdisciplinary complex is involved in the subject of climate change, and look to construct interdisciplinary researches and creations, in which we focusing important questions and concepts that cross climate change approaches.
Every day we are drowned by the excess of information and news of climatic catastrophes, scenes that show places devastated by natural disasters, such as dried up rivers, water shortages in cities and the melting of polar ice caps. These images and information create narratives and stories about the threat that climate change poses to the survival of the world. And often, these stories possess sterilizing effects by creating the sensation that nothing can be done because the scale of the problem has already become so big to the point that we don’t even know what actions to take and therefore become paralyzed. In this context we look to think critically about the quality of the information that is being produced about climate change, seeking to think of communications that create other possible narratives and stories to stimulate other types of thinking related to the environment, to the climate, and life. We believe as the author Donna Haraway suggested, with her challenge to live ‘with the problem’ of climate change, we should create multiple possibilities in the face of these sterilizing stories. We shouldn’t think that there’s no way out, but rather we should create multiple ways out, developing other trains of thought and new collective actions to deal with the climate changes already in motion.

It’s with this intuition that in our research we seek to create other means, together with communication, telling new stories and establishing connections with different ways of knowledge. We believe in the interaction between art, communication and science as a powerful possibility to disseminate new scientific findings in a different approach. In this sense, we developed productions that seek to provoke the public to rethink climate change communication creations like videos, reports, art installations, and workshops. We are developing a video collective creation workshop named TransClimatic VideoNarratives that we will work aesthetic and videos concepts to create new stories with the public. How do people understand and interact with the climate and nature? How can we establish relationships with water and earth, and how can we establish connections with the climatic elements and feelings that they can generate? Therefore, we aim to study possibilities of generating knowledge from sensory experiences in order to enfold climate change subjectivity and create new stories and possibilities seeking to contribute for the dissemination of knowledge and promote public participations. Our studies integrate the activities of the sub-group Scientific Communication assessment of the Change from the Brazilian Network on Global Climate Change Research (Rede CLIMA).

2240 - Perceptions of climate change

**ORAL PRESENTATIONS**

**O-2240-01**

International Perceptions of Climate Change Over the Past 25 Years: A Review

W. Poortinga (1) ; S. Capstick, (2) ; L. Whitmarsh (3) ; N. Pidgeon (2) ; P. Upham, (4)

(1) Cardiff University, Welsh School of Architecture, Cardiff, United Kingdom (UK); (2) University of Sussex, Brighton, United Kingdom (UK); (3) Cardiff University, School of Psychology, Cardiff , United Kingdom; (4) University of Leeds, School of earth & environment, Leeds, United Kingdom

The ways in which individuals, societies, and polities respond to climate change are in many cases contingent on public perceptions of its causes, consequences, and wider implications. Understanding popular opinion on climate change is therefore critically important to enable a social transformation to a low–carbon economy. Public perceptions of climate change are known to differ between nations and have fluctuated over time. Several explanations have been put forward for these variations. With over two decades of research on public perceptions of climate change, we are now in a position to take stock of the key trends over this time period and the factors behind the changes. In this contribution we will present the findings from a systematic literature review of studies that have used longitudinal methods to examine changes in and drivers of public opinion on climate change. In this review we consider early, seminal work on public perceptions of climate change from the 1980s onwards, and national and international surveys with a longitudinal component. Studies point to growing scepticism in the later 2000s in a limited number of developed countries. However, most parts of the world have seen growing concern about climate change in same time periods. We conclude that the imbalances in the literature toward polling data, and toward studies of public perceptions in Western nations (particularly the United States), leaves much unknown about the progression of public understanding of climate change worldwide. Furthermore, more research is required that uses inferential statistical procedures to understand the reasons behind trends in public perceptions. (Session 2240 – Perception of climate change).

**O-2240-02**

Public perceptions of weather and climate change in the United Kingdom

W. Bruine De Bruin (1) ; AL. Taylor (1) ; S. Dessai (2) ; C. Lefevre (3)

(1) Leeds University Business School, Centre for Decision Research, Leeds, United Kingdom; (2) University of Leeds, Leeds, United Kingdom; (3) Northumbria University, School of psychology, NewCastle, United Kingdom

BACKGROUND.

Public perception surveys in the US have suggested that Americans’ concerns about climate change are related to their experiences of very hot weather. Such findings raise questions about the limits for change beliefs of people in regions with moderate climates, including the United Kingdom (UK). Indeed, our work has suggested that UK residents may actually feel good about the prospect of warmer summers (e.g. Lefevre et al., 2015, see also Palutikof et al. 2004). Such findings raise the question of whether other types of locally experienced weather may be associated with concerns about climate change, among residents of those countries. Indeed, relatively little is known about whether public concerns about climate change may also be associated with perceived changes in other weather-related events, such as heavy rainfall. We therefore examined (1) the extent to which UK residents perceive different types of weather and related events to have changed in frequency over the lifetimes; and (2) the relationship between perceived changes in the frequency of these events and climate change belief.

METHOD.

We report on an initial UK–wide survey that was conducted January/February of 2013, with longitudinal follow–up surveys occurring in October 2013, April 2014, and July 2014. These surveys contained items asking participants about the extent to which they perceived nine types of weather–related events to have increased or decreased in frequency over their lifetime (including heatwaves and heavy rainfall, among others). Participants also rated their concerns about climate change, using a reliable 3–item assessment.

RESULTS.

Our analyses showed that participants tended to perceive wet–weather and water related events (heavy rainfall, flooding, coastal erosion) to have increased in frequency over their lifetime, while hot summers and heatwaves were perceived to have decreased over their lifetime. Moreover, controlling for the effects of demographic variables and environmental values, we found that perceived increases in wet–weather were significantly associated with greater climate change concerns, with perceived change in the frequency of hot–weather making a comparatively small contribution. These findings held in the initial survey as well as the longitudinal follow–up surveys that were held as the weather changed across seasons.

CONCLUSIONS.

We found that amongst UK residents, perceptions of wet weather and related events are more strongly associated with beliefs about climate change than perceptions of hot weather. These findings suggest that those seeking to communicate about climate change with audiences in response with temperate climates should not limit their focus to heat–related impacts, but also emphasize other types of locally salient weather.
Analysis of factors shaping small-scale farmers' perceptions about climate change in South Africa: A behavioral approach

P. Hitayezu (1); E. Wale (1); G. Ortmann (1)
(1) University of KwaZulu-Natal, School of Agricultural, Earth, and Environmental Sciences, Pietermaritzburg, South Africa

Raising public awareness of the real threat posed by CC has been a common pledge in many countries’ CC response policies. In many cases, however, tendencies by policymakers to overlook the differences in public opinions have resulted in policy instruments focused on passive resistance, and even active opposition. Therefore, effective CC communication requires a good understanding of public opinions and a recognition of individual variation in learning processes. In South Africa, for example, recent empirical studies have shown that small-scale farmers hardly recognize the patterns of local climatic changes. The studies, however, have simplistically argued that the misperceptions could be due to the complexity of biophysical processes that can be hardly discerned by farmers. They have often overlooked the importance of socio-psychological, institutional and cultural processes underlying individual perceptual formation.

Based on key insights of the behavioural decision research, this study investigated the affective, experiential, cognitive and cultural factors shaping the perceptions about climate change among small-scale farmers in the midlands region of KwaZulu-Natal, a major hotspot of climate change in South Africa. Principal component analysis of perceptions about climate change revealed two contrasting perceptual shapes. Whilst meteorological records indicated that the area has experienced drying trends in summer coupled with warming and wetting trends in winter over the last four decades, CCP1 score revealed inaccurately perceived trends of cooling and drying winters and warming and drying summers. CCP2 score exhibited stark similarity with meteorological observations.

Using a Double–Hurdle estimation strategy, the results of the Probit model suggested that climate change perception is triggered by emotive factors (holistic affect) and value judgement, as well as socio-demographic factors such as age, gender, education, and agro–ecological conditions. In line with the conceptual expectations from the behavioural approach, the results of the Truncated regression model showed that the CCP1 score increases with holistic affect and inherently experiential socio-demographic factors such as age, and distance to the rivers, whilst the CCP2 score is influenced by social and cultural factors, including knowledge, education, extension, and trust.

Based on these findings, the study concludes with some recommendations for effective regional CC communication strategies that recognize individual variation in learning processes.

Mental models of climate change: Basis for risk evaluation, policy support, and message reception

G. Böhm (1); A. Bostrom (2)
(1) Psychology, Bergen, Norway; (2) Policy, Seattle, United States of America

Human behavior plays a central role in climate change risks. In addition to precipitating rapid global warming by burning fossil fuels, humans can also act to prevent, ameliorate or adapt to climate change and its consequences. It is therefore important to understand how people perceive climate change, its impacts, and the opportunities for and effects of human actions. Mental models are an essential part of risk perception; they shape subjective risk evaluations, policy preferences, and the reception of risk communications.

We present 3 studies in which we pursued three aims: (a) describe lay causal mental models of climate change risks, (b) relate mental models to risk judgments and policy preferences, (c) draw conclusions concerning the communication of climate change risks.

Study 1 (N = 133) employs a cognitive mapping technique to elicit people’s mental models. Participants also evaluated a set of climate change risks on several psychometric risk scales. Results show that mental models are structured according to a causal chain that ranges from attitudes via behaviors, pollution, and environmental degradation to impacts on humans. These components differ systematically in perceived risk and perceived controllability. Network analysis reveals that lay models tend to be simple and unconnected.

Study 2, an experiment with USA MTurk participants (N = 892) suggests that even when controlling for causal beliefs, mental models can have a significant effect on policy support, but perceptions of the costs of action have a much larger deterrent effect on support. Participants were assigned randomly to experimental conditions, two of which were designed to promote concrete, specific thinking, two to promote abstract, goal-oriented thinking. Participants in an abstract mindset were significantly more likely to support increasing taxes on fossil fuels. But the effect is much smaller than the association with perceived social and personal costs. Causal beliefs—such as that increasing taxes on fossil fuels will effectively slow or stop climate change—remain positively associated with support for such taxes, whereas political ideology drops out as a predictor of policy support, once mindset and other factors are taken into account.

Study 3, a cross-national survey, demonstrates the important role of risk perceptions and causal beliefs in the formation of policy preferences and participation in action. Study 3 employed undergraduates from six countries: Austria, Bangladesh, Finland, Germany, Norway, and USA (total N = 664). Five constructs were measured: risk perception, perceived causes, perceived consequences, perceived effectiveness of a set of policy actions, and support for the same set of policy actions. Regression analyses with policy support as criterion and the other factors as predictors show that policy support can be predicted by risk perceptions and causal mental models. In all analyses, adding perceived causes and perceived effectiveness as predictors adds significant explained variance. Perceived effectiveness is generally a stronger predictor than ascribed causes.

Taken together, the studies show that mental models shape both people’s evaluation of climate change risk and their support for specific policy options. Causal beliefs seem more important that political ideology, but perceived costs may have deterrent effects. One implication of the results is that all communications must relate to people’s mental models and that promoting an abstract, goal-oriented mindset strengthens policy support. Furthermore, communicating the effectiveness of policy actions may influence support for these actions more than providing other causal information (knowledge). The current results should help identify the exact mediating roles of mindset, perceived risk, causal beliefs, and perceived policy effectiveness in shaping policy support and the processing of communications.

Believing, Belonging and Behaving: Exploring Mismatch between Climate Change Perceptions and Individual Mitigation Behaviours across 27 European Countries

R. Mattarak (1)
(1) International Institute for Applied Systems Analysis, World Population Program, Laxenburg, Austria

Individual behaviour is key to CO2 emission reduction. Despite increased awareness of climate change, climate-related beliefs however do not always translate into actions. This study aims to explain the mismatch between beliefs and behaviours by investigating the underlying drivers of individual socio-demographic, meso and macro level factors across countries and over time. The study employs a novel 3Bs framework –believing, belonging, behaving– originally developed to analyse the collective, social, and cultural factors shaping the perceptions about climate change among small-scale farmers in the midlands region of KwaZulu-Natal, a major hotspot of climate change in South Africa. The 3Bs framework is a set of policy actions, and support for the same set of policy actions. Regression analyses with policy support as criterion and the other factors as predictors show that policy support can be predicted by risk perceptions and causal mental models. In all analyses, adding perceived causes and perceived effectiveness as predictors adds significant explained variance. Perceived effectiveness is generally a stronger predictor than ascribed causes.

Taken together, the studies show that mental models shape both people’s evaluation of climate change risk and their support for specific policy options. Causal beliefs seem more important that political ideology, but perceived costs may have deterrent effects. One implication of the results is that all communications must relate to people’s mental models and that promoting an abstract, goal-oriented mindset strengthens policy support. Furthermore, communicating the effectiveness of policy actions may influence support for these actions more than providing other causal information (knowledge). The current results should help identify the exact mediating roles of mindset, perceived risk, causal beliefs, and perceived policy effectiveness in shaping policy support and the processing of communications.
is based on the Eurobarometer surveys for the years 2008, 2009, 2011, and 2013 (Modules 69.2, 72.1, 75.4 and 80.2, respectively) covering over 100,000 respondents in 27 member countries of the European Union. Preliminary results show that women and the highly educated express greater concern about climate change and are more likely to undertake personal actions to mitigate climate change. The public concern about climate change however has decline, especially in the period after the 2008 financial crisis. That general deglaciation of the world was linked to multiple perceptions towards climate change and climate-related actions, and, importantly, for the extent of the mismatch between attitudes and actions. For instance, residents in countries like Austria, Spain, and Slovenia have both a relatively high concern about climate change and a relatively low proportion of individuals undertaking mitigation actions. On the other hand, a group of many new EU member countries such as Estonia, Latvia, Lithuania and Poland display both relatively low level of concern about climate change and low level of mitigation actions. Likewise, the same proportion of individuals from Luxembourg and Bwatar (73.0%) perceived climate change as a very serious problem but only 30.8% of residents in the latter perform mitigation actions as compared to as many as 79.1% of the former. Understanding what barriers prevent individuals from some countries to take actions despite their climate change concern is therefore crucial for policy interventions.

2240—POSTER PRESENTATIONS

P-2240-01

Climate Change Perception and Adaptation Strategies In Osun State

R. Adeyemo (1)

(1) obafemi Awolowo University, Agricultural Economics, Ile-Ife, Osun State, Nigeria, Federal Republic of

The impact of a changing climate are already being felt in Sub Saharan Africa with more droughts, more floods on the coastlines of West Africa, more strong storms and more heat waves. To understand how individuals, firms and governments, drawing resources away from developments. Continuing climate change at current rates will pose increasingly severe challenges for developments. Since over 90% of agriculture in Sub Saharan Africa is rain fed and water supplied are expected to decrease and to become more erratic in most regions, local water management such as micro-catchments, dams and tanks and small irrigation from underground water will be key opportunities for adaptation. Malaria is spreading to higher previously safe altitudes and becoming resistant to drugs.

The objectives of this research are to; determine farmers perception to climate change, based on farmers field experiences, explore innovative adaptation approaches needed in this enviro and examine tested traditional knowledge useful for adaptation at the local setting

The study is based on four local government areas in Osun State. The areas comprise the food basket areas of the state. Structured questionnaires was developed to generate primary data which are complimented with secondary data. The data collected are subjected to descriptive and statistical analysis.

It is on record that agricultural productivity has declined in all the zones in Nigeria including the areas of study. The region economies are highly dependent on natural resources. This research will be able to indicate strategies for climate change adaptation in agriculture, what lessons have been identified and new innovative approaches that can be applied to similar areas in Sub Saharan Africa.

P-2240-02

Heterogeneity of climate change perceptions in two Caboclos’ communities of the Amazon Estuary, Brazil

V. Zeidemann (1); O. Almeida (2); S. Rivero, (1); CM. Alvez-Valle, (3); N. Moreira, (1)

(1) Federal University of Pará, Economic Graduation Program, Belem, Pará, Brazil; (2) Federal University of Pará, NAEA, Belem, Brazil

There is a general consensus that peoples and societies perceptions are a necessary prerequisite for adaptation and responses to climate change (Maddison 2006, Brain et al. 2009, Capstick et al. 2015). However, climate change impacts, and consequently perceptions, are unevenly distributed with respect to both perceptions towards climate change and climate-related actions, and, importantly, for the extent of the mismatch between attitudes and actions. For instance, residents in countries like Austria, Spain, and Slovenia have both a relatively high concern about climate change and a relatively low proportion of individuals undertaking mitigation actions. On the other hand, a group of many new EU member countries such as Estonia, Latvia, Lithuania and Poland display both relatively low level of concern about climate change and low level of mitigation actions. Likewise, the same proportion of individuals from Luxembourg and Bwatar (73.0%) perceived climate change as a very serious problem but only 30.8% of residents in the latter perform mitigation actions as compared to as many as 79.1% of the former. Understanding what barriers prevent individuals from some countries to take actions despite their climate change concern is therefore crucial for policy interventions.

Our study aims to explore (1) how caboclos communities’ residents in two islands of the Amazon Estuary, Brazil, perceived climate changes (2) how those perceptions varied among respondents and communities, and (3) what factors influenced perception heterogeneity to climate change. The caboclos communities studied have their livelihoods based mainly on açaí berries collection, fishing, activities, and shrimp harvest. Therefore, we explore how those communities perceived climate change impacts, specifically temperature, rainfall and tide level changes, on those three economic activities, and what factors determine perception variation regarding the climate change impacts on those activities.

To collect data on how caboclos communities perceived climate changes on temperature, rainfall and tide level, and their impacts on açaí berries collection, fishing, and shrimp harvest, we applied structured interviews to 239 residents of Arumanduba and São João Batista communities, in the municipality of Abertuba. Besides climate change perception questions, we also gathered information on gender, age, level of education, time of residence at the community, property size, and links to fishers association and workers unions. We also applied focus group discussions to further understand residents’ perceptions.

Preliminary results showed that perception to climate change varied according climate change type (temperature, rainfall, and tide level changes) and also on the type of economic activity being impacted by those changes. Gender and affiliation to fishers association and worker unions seems to influence perceptions regarding rainfall and tide level changes, but not on temperature changes. Further analysis will be performed on communities results, and also to determine if residents’ age, level of education, time of residence, and property size affect their perception regarding climate changes occurring in the last 20 years, and on the impact of those changes on fishing, açaí berries harvest and shrimp harvest activities.

Knowledge on how caboclos communities perceive climate changes and their impacts, but also the factors that affect the way those communities perceive those changes and impacts, are extremely important to assist policy aiming to foster adaptation and also decrease vulnerability of those communities to future climate changes.

P-2240-03

Has self-interest of climate scientist influenced their perceptions of global environmental change? A Rebuttal to climate change contrarians’ allegation against climate scientists

HJ. Bak (1)

(1) Kyung Hee University, Center for Science, Technology & Society, Seoul, Republic of Korea

GEC is still controversial in the public in many countries, although scientists almost reached a consensus over the causes and results of it. One of the reasons is the attack against climate science and IPCC by climate change contrarians. They have claimed that mainstream
climate scientists, influenced by their interest of research for the environment, have expressed the seriousness of GEC for political purposes and made an uncertain claim of anthropogenic global warming. Social scientists, historians, and environmental NGOs have been attacked, these contrarians challenge the scientific establishment by debunking the influence of their own conservative ideological orientation, conservative think tanks, and the fossil fuel industry on their activity. However, little effort has been made to examine the contrarians’ claims with empirical evidence: whether or not climate scientists’ warning on GEC has been influenced by their own professional ideology and interests. Among many results, there is a serious methodological challenge to answer this question: it is difficult to know whether the high level of concern about GEC among climate scientists has resulted from their expertise (as most scientists claim) or their interests (as contrarians claim).

This study attempts to test the validity of the contrarians’ allegation by taking an innovative way to separate potential differential behaviours from interactional experts vs. interventional experts on climate scientists’ concern about GEC. To use Collins and Evans (2002, 2007)’ terms, this study classified a sample of Korean scientists (n=365) into three groups, 1) contributory experts who conduct climate research, 2) interactional experts who do not conduct climate research but have much knowledge on it, and 3) scientists–in-general who now have no knowledge on climate change, and compared their perceptions/presentations of global climate change. In this way, this study attempts to influence the distinction of expertise (contributory experts vs. interventional experts vs. scientists in general) and the influence of interests controlling for expertise (contributory experts vs. interactional experts). Using this classification of expertise, this study hypothesizes that, if scientists’ research fuses have a negative effect on their perceptions/presentations of GEC, contributory experts having such interests may perceive/present GEC as a more serious problem than may other scientists who do not have such interests. In particular, if the contrarians’ allegation is valid, there should be a significant difference in the perceptions/presentations of GEC between contributory experts and interactional experts who have a high level of environmental interests, but not have a professional interests in climate research such as research funding.

The results of this study demonstrate that there has been little difference in the perceptions/presentations of GEC among contributory experts, interactional experts, and scientists in general. The same was the case even when covariates such as gender, age, income, and political ideology were controlled for. These results therefore strongly suggest that the allegation against mainstream climate scientists made by contrarians was hard to find ground and that we should take climate scientists’ warning about GEC seriously. Perhaps, climate science has been politicized too much.

**P-2240-05**

**Exploring The Concerns Of Emerging Climate Sceptic Groups Within Civil Society**

M. Bliss (1)

(1) The REAL Institute, EDDON, France

Exploring the concerns of emerging climate sceptic groups within civil society, a proportion of society increasingly present them are seen as more competent and warm than science. Using the information age to research the past, observe the present and are subsequently becoming organised to protect the future, reflecting a perception of man’s influence on climate change – whether intentional or unintentional.

**P-2240-06**

**How do perceptions of climate change affect performance of risk management instruments & farmer welfare in Malawi?**

R. Cavatassi (1); A. Cattaneo (2); J. Graff-Zivin, (3); N. McCarthy, (4); L. Lipper, (5)

(1) Food and Agriculture Organization, Agricultural Development Economics Division, Rome, Italy; (2) Food and Agriculture Organization of the United Nations (FAO), Agricultural Development Economics Division, Rome, Italy; (3) UC San Diego, Economics, San Diego, United States of America; (4) LEAD Analytics, Washington, DC, United States of America; (5) FAO of the UN, Agricultural development economics division, Rome, Italy

This paper provides new insights on how climate change affects Malawian farm households’ risk management options. The options considered in our farm–level stochastic simulation model are (i) the adoption of risk–smoothing farmer practices, (ii) diversification among crops, (iii) safety nets, and (iv) other public interventions such as improving extension and providing better climate information. A traditional risk management approach typically assumes that probabilities are known by all actors. However, climate change can affect the probability and severity of yield losses in ways that are difficult for individual farmers to incorporate in their decision–making.

Simulations are run solving a stochastic farm model where a farmer chooses a staple crop and technique (conventional or traditional) plus up to one diversification among crops, smoothing farm practices, (ii) diversification among crops, (iii) safety nets, and (iv) other public interventions such as improving extension and providing better climate information. A traditional risk management approach typically assumes that probabilities are known by all actors. However, climate change can affect the probability and severity of yield losses in ways that are difficult for individual farmers to incorporate in their decision–making.

In the results presented here we focus on how improving climate information available to farmers changes the expected outcomes. We refer to a misalignment in expectations when farmers have access to climate information to evaluate the change in systemic risk brought about by climate change and behave as if this distribution had not changed. From the results in Table 1, we observe that (i) mean profits can be greatly affected by lack of information under increased variability of rainfall in sub–humid areas, and (ii) an increased variability of temperature in semi-arid areas can have a considerable negative effect if not anticipated.

**P-2240-04**

**The green of your eyes: Social judgments of different types of pro-environmental behaviours**

R. Bertoldo, (1); P. Castro (2)

(1) ISCTE-IUL, Cis, Lisbon University Institute, Lisbon, Portugal; (2) ISCTE-IUL, social psychology, Lisbon, Portugal

There is today an international consensus on the fact that our societies have to alter the way they interact with the environment (IPCC, 2013). Today, environmental claims are part of our daily lives to the point that they integrate different types of environmentally significant behaviours (Stern, 1999): activist, non-activist and private environments. A previous study has shown that pro-environmental behaviours can be associated with the perception of both competence and warmth – i.e., people that present them are seen as more competent and warm than those who do not. However, it is not tested whether people that do not. However, it is not tested whether people that present them are seen as more competent and warm than others. These results confirm the distinction between perceived agency and communion. Given that all targets behave and demonstrate agency towards the environment, they are all seen as equally competent. But the activist target, which demonstrates intentions to change the current state of affairs, is seen as less cooperative and communal than the targets presenting pro-environmental behaviours form the private sphere. Implications of these results for the environmental social change are discussed.

**P-2240-05**

**Exploring The Concerns Of Emerging Climate Sceptic Groups Within Civil Society**

M. Bliss (1)

(1) The REAL Institute, EDDON, France

Exploring the concerns of emerging climate sceptic groups within civil society, a proportion of society increasingly present them are seen as more competent and warm than science. Using the information age to research the past, observe the present and are subsequently becoming organised to protect the future, reflecting a perception of man’s influence on climate change – whether intentional or unintentional.

**P-2240-06**

**How do perceptions of climate change affect performance of risk management instruments & farmer welfare in Malawi?**

R. Cavatassi (1); A. Cattaneo (2); J. Graff-Zivin, (3); N. McCarthy, (4); L. Lipper, (5)

(1) Food and Agriculture Organization, Agricultural Development Economics Division, Rome, Italy; (2) Food and Agriculture Organization of the United Nations (FAO), Agricultural Development Economics Division, Rome, Italy; (3) UC San Diego, Economics, San Diego, United States of America; (4) LEAD Analytics, Washington, DC, United States of America; (5) FAO of the UN, Agricultural development economics division, Rome, Italy

This paper provides new insights on how climate change affects Malawian farm households’ risk management options. The options considered in our farm–level stochastic simulation model are (i) the adoption of risk–smoothing farmer practices, (ii) diversification among crops, (iii) safety nets, and (iv) other public interventions such as improving extension and providing better climate information. A traditional risk management approach typically assumes that probabilities are known by all actors. However, climate change can affect the probability and severity of yield losses in ways that are difficult for individual farmers to incorporate in their decision–making.

Simulations are run solving a stochastic farm model where a farmer chooses a staple crop and technique (conventional or traditional) plus up to one diversification among crops, smoothing farm practices, (ii) diversification among crops, (iii) safety nets, and (iv) other public interventions such as improving extension and providing better climate information. A traditional risk management approach typically assumes that probabilities are known by all actors. However, climate change can affect the probability and severity of yield losses in ways that are difficult for individual farmers to incorporate in their decision–making.

In the results presented here we focus on how improving climate information available to farmers changes the expected outcomes. We refer to a misalignment in expectations when farmers have access to climate information to evaluate the change in systemic risk brought about by climate change and behave as if this distribution had not changed. From the results in Table 1, we observe that (i) mean profits can be greatly affected by lack of information under increased variability of rainfall in sub–humid areas, and (ii) an increased variability of temperature in semi-arid areas can have a considerable negative effect if not anticipated.

**P-2240-04**

**The green of your eyes: Social judgments of different types of pro-environmental behaviours**

R. Bertoldo, (1); P. Castro (2)

(1) ISCTE-IUL, Cis, Lisbon University Institute, Lisbon, Portugal; (2) ISCTE-IUL, social psychology, Lisbon, Portugal

There is today an international consensus on the fact that our societies have to alter the way they interact with the environment (IPCC, 2013). Today, environmental claims are part of our daily lives to the point that they integrate different types of environmentally significant behaviours (Stern, 1999): activist, non-activist and private environments. A previous study has shown that pro-environmental behaviours can be associated with the perception of both competence and warmth – i.e., people that present them are seen as more competent and warm than those who do not. However, it is not tested whether people that do not. However, it is not tested whether people that present them are seen as more competent and warm than others. These results confirm the distinction between perceived agency and communion. Given that all targets behave and demonstrate agency towards the environment, they are all seen as equally competent. But the activist target, which demonstrates intentions to change the current state of affairs, is seen as less cooperative and communal than the targets presenting pro-environmental behaviours form the private sphere. Implications of these results for the environmental social change are discussed.
Table 1. Impact on mean profits of increasing by 30% the standard deviation of rainfall (Rain SD) or of temperature (Temp SD), depending on whether the change in variability is correctly anticipated by the farmer or not (unanticipated).

<table>
<thead>
<tr>
<th>Malawi AEZs</th>
<th>Mean Profits (Malawian Kwachas)</th>
<th>Scenarios</th>
<th>Anticipated climate change</th>
<th>Unanticipated climate change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tropic warm/semi-arid</td>
<td></td>
<td>Baseline</td>
<td>5,578</td>
<td>5,578</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rain SD + 30%</td>
<td>2,430</td>
<td>2,102</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Temp SD + 30%</td>
<td>6,056</td>
<td>4,901</td>
</tr>
<tr>
<td>Tropic warm/sub-humid</td>
<td></td>
<td>Baseline</td>
<td>5,859</td>
<td>5,859</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rain SD + 30%</td>
<td>7,950</td>
<td>2,244</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Temp SD + 30%</td>
<td>3,627</td>
<td>3,627</td>
</tr>
<tr>
<td>Tropic cool semi-arid &amp; subhumid</td>
<td></td>
<td>Baseline</td>
<td>10,719</td>
<td>10,719</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rain SD + 30%</td>
<td>4,980</td>
<td>4,729</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Temp SD + 30%</td>
<td>7,944</td>
<td>9,877</td>
</tr>
</tbody>
</table>

In our analysis, improving information available to farmers addresses this misalignment by providing the correct probability distribution to farmers managing risk. The paper then provides insight on the robustness of different instruments, such as diversification or safety nets in the face of the knowledge of the probabilities of weather events, and the value of providing information in the efficiency of such instruments. Budgetary implications are also explored for different instruments such as weather index insurance and safety nets. Results indicate that misalignment of farmer expectations may cause large budgetary outlays by government due to a lack of appropriate adaptation decisions when only limited information is available to farmers.

**P-2240-07**

"Visions of the future" from selected scenarios: Science warnings, the changing of scarcity concept and prospects for a new society

R. Corazza (1); P.S. Fracalanza, (2); E. Ortega, (3); MJ. Bacin, (2)

(1) Geosciences Institute / State University of Campinas – IG/ UNICAMP, Science and Technological Policies, Campinas, SP, Brazil; (2) Instituto of Economics, Campinas, SP, Brazil; (3) Food Engineering Faculty, Ecological engineering and applied informatics laboratory, Campinas, Brazil

Most of conventional, non-scientific or specialized media nowadays focus on the problems of financial-economic international crisis and on worldwide terrorism actions. Challenges to curb Climate Change and the other major planetary environmental problems appear in the main information vehicles as specific topics, frequently disconnected to these other urgent and fair issues of economic possibilities of the world and the global safety under the menace of the growing forces of fundamentalism and intolerance.

Yet, these planetary challenges are deeply imbedded in our social, economic and geopolitical world. Facing the first ones will require profound and extensive reorientation of the latter. There will be no possible escape from a dystopic future for the great majority unless this fundamental interdependence are recognized and proper, creative faced by world leaders, jointly with citizens, businesspersons, and society as a whole.

The scientific literature on the future prospects of the world in this sense spreads from late 1960s to the present and brings together a set of issues that can be enlightening when it comes to devise possible paths to alternative socio-economic and political arrangements to face current predicaments of humankind.

This paper draws on the results of a critic literature review on the topic of the visions of future, highlighting the contributions of the reviewed works on three selected and interrelated issues: Science warnings, the underlying scarcity concept (being it openly stated or not) and the prospects of the future of the society (whether it be utopian or dystopian).

The Table 1, below, summarize the contributions reviewed, its authors and the disciplinary scientific field, and institutional and historical contexts within which they have been proposed. The main, even if not the unique, criteria for selecting these works were the adherence to the theme and the prominence of them in the literature reviewed. The sources employed as bases for the survey were Scielo, Periodicos CAPES and Scholar Google for the systematic review and selected books and papers for backward and forward chaining review.

Table 1. Visions of the Future: contributions and reviewed authors

<table>
<thead>
<tr>
<th>Contribution</th>
<th>Date</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environment, Power and Society</td>
<td>1971</td>
<td>Howard Odum</td>
</tr>
<tr>
<td>The Limits to Growth</td>
<td>1972</td>
<td>Donella and Dennis Meadows and colleagues</td>
</tr>
<tr>
<td>Beyond the Limits</td>
<td>1992</td>
<td>Idem</td>
</tr>
<tr>
<td>Catastrophe or New Society: a Latinamerican World Model</td>
<td>1976</td>
<td>O. Herrera and colleagues</td>
</tr>
<tr>
<td>IPCC (Intergovernmental Panel on Climate Change) 4th Assessment Report</td>
<td>2007</td>
<td>R. K. Pachauri; A. Reisinger</td>
</tr>
<tr>
<td>Ecosystems And Human Well–Being</td>
<td>2005</td>
<td>Millenium Ecosystems Assessment</td>
</tr>
</tbody>
</table>

The main purpose of this paper is to draw from the reviewing of these selected contributions a set of answers for the following questions: i) which are the scientific warnings made in terms of environmental change? ii) which is the underlying concept of scarcity? iii) which are the ideas or the prospects for the reorganization of social and economic life? iv) which roles are social and economic actors supposed to play in order to implement this reorganization?

**P-2240-08**

Does poor understanding of causes for climate change lead to bad protective choices?

G. Guedes (1); A. Simao (2); R. Raad (3); G. Assunção (4)

(1) Federal University of Minas Gerais, Department of Demography, Belo Horizonte, Minas Gerais, Brazil; (2) Federal University of Minas Gerais, Center for development and regional planning, Belo Horizonte, Brazil; (3) Federal University of Minas Gerais, Department of Economics, Belo Horizonte, Brazil; (4) Federal University of Minas Gerais, Department of statistics, Belo Horizonte, Brazil

In this paper we analyze how people’s perception of causes for climate change, and their understanding of global warming, may be associated with their behavior regarding flood preparedness. We also analyze if their social representation of floods is affected by how they
Perceptions of climate change in the mainstream media as portrayed through the coverage of the water crisis in São Paulo

R. Henriques Melo-Santos (1); C. Nolasco (2); M. Lahsen, (3)

(1) INPE – National Institute For Space Research, Earth System Science Centre, São José dos Campos, SP, Brazil; (2) INPE – Brazilian National Institute for Space Research, CCST – Earth System Science Centre, São José dos Campos, SP, Brazil; (3) National Institute for Space Research, Earth System Science Centre (ccst), São José dos Campos, SP, Brazil

For many decades, drought has been a very cruel and close reality to millions living in the Northeast region of Brazil. By contrast, for those in the Southern regions of the country, water scarcity has rarely been a matter of concern and was associated only with remote, socio-economically deprived regions. That reality changed in 2014 when the megacity of São Paulo, home to 12 million people, suffered a serious water crisis. The magnitude of the water crisis and the speed in which it occurred took many by surprise and it is referred to as the most severe in decades. Its consequences unfolded throughout the region like an epidemic and turned into front page news. Among the causes attributed to the water crisis was irresponsible management of water resources, excessive water use by the population and an extreme environmental situation. Scientists have been warning that intense drought and lack of rainfall throughout Brazil is a result of climate change (Gutiérrez et al., 2014), and that further warming and reduction in precipitation is projected for the southeast of Brazil for the coming decades (Chou et al., 2014). This present study examines the portrayal of climate change in the mainstream media, as portrayed through the coverage of the water crisis in São Paulo. It also examines the importance given to scientific data on the water crisis and seeks to understand how the most influential outlet press, the newspaper Folha de São Paulo, explains the causes of the water crisis, in particular the extent to which it covered governance and climate change. Attention is given to the presentation of scientific literature and management of the water crisis addressed in the news, took into consideration knowledge and data produced by the scientific community. A sample of reports, published during the period of August 2014 to March 2015 in the newspaper Folha de São Paulo, were classified by section and type, and thus, identifying whether the newspaper relates the crisis to climate change or to governance issues or both, and whether the newspaper content is based on scientific or non-scientific information. Understanding how issues are framed in this and other national news media is important because they shape public knowledge, customs and perceptions of the Brazilian society.

P-2240-09

Navigating the line between participation and tyranny - Lessons learned in using participatory methods to engage community members in pro-environmental behaviours in rural China: The Case of Farm in a Box

E. Kennedy (1); S. Evans, (2)

(1) Lund University, Social Work, Lund, Sweden; (2) Good to China, Shanghai, China

Discussions and responses to climate change have predominantly remained at the global and national levels with limited inclusion of people who live in regions that are heavily impacted by and vulnerable to climate change. The implications of climate change at the local level and the possible positive impact of locally driven climate change adaptation are largely overlooked within the international community of climate change experts. It is necessary to not only include, but to also work closely with local communities in the discussion of climate change sustainable development and resilience building as local communities provide a source of local knowledge rooted in cultural traditions as well as a source of community level action. However, navigating between participatory methods and tyranny is an issue that has received attention within participatory research and community engagement literature. Focusing on the case study of Farm in a Box, a sustainable food source that promotes pro-environmental behaviours and education opportunities, we will examine the lessons learned in the process of using participatory methods to engage community members in pro-environmental behaviours in rural China.

P-2240-10

Learning about climate-related risks: decisions of fish farmers in a role-playing simulation game

P. Lebel (1); L. Lebel (1)

(1) Chiang Mai University, Unit for Social and Environmental Research, Chiang Mai, Thailand

Background: Successful river-based cage aquaculture in Northern Thailand depends on managing a number of climate-related risks. Previous surveys and observation of recent high flow or flood events as well as an extreme seasonal drought with low flows have shown that risks are season-, river- and place-specific implying that the experience and risk profiles of individual farms vary substantially. Earlier work also showed that farmers use a combination of adjustments to rearing practices, cropping calendars, as well as financial and social policies, as well adherence to protective and preventive behavior.

Purpose: The purpose of this study was to improve understanding of how farmers make investment decisions in their fish farms when faced with risks from floods that are imperfectly known and which may be changing.

Methods: A role-playing simulation game was created to capture some of the key features of the decision-making context and explore with farmers in the field on hand-crafted, simulation game...
Results: As hypothesized more frequent or larger impact floods reduced cumulative profits. Farmers reduced their stocking densities when playing in games with high likelihood of floods but did not do so as expected when impacts were larger. Farmers found it’s harder to learn – choose the most optimal density or improve score within a game – when floods were common or had large impacts. Farmers learnt most when risks were decreasing and least when there were increasing. Providing information about likelihoods prior to a game had no significant impact on performance or decisions, even though interviews implied a reasonable understanding of likelihood information. Within individual games farmers responded to a flood with a reduction in density in the next crop if they had just chosen high, but with a shift to high if they had previously chosen low. Post-game interviews suggest most farmers found the simulation game represented key features of their decision context, the main discrepancy being inability to take short-term measures to reduce losses when a flood was imminent.

Significance: The methods and findings of this study underline the importance of understanding decision-making behavior around risks for climate risk management. The novel combination of experimental, role-playing and qualitative methods revealed limitations in common assumptions about the ease of learning about likelihoods and their consequences from experience. In the context of climate-related risks and a role-playing game situation, the findings suggest there may also be an emotional rather than purely analytical response to losses. The findings also suggest that decision support systems for aquaculture need to take into account how recent experiences and other factors influence risk perceptions and decisions.

P-2240-14
Perception, Collapse and Climate Change: an Anthropological Theory Approach
F. Miguel (1); I. Ibiapina (2); M. Curi (1)
(1) Universidade de Brasilia, Centro de Desenvolvimento Sustentavel, Brasilia, Distrito Federal, Brazil; (2) Universidade de Brasilia, Antropologia social, Brasilia, Distrito Federal, Brazil

In this paper, we intend to discuss from the point of view of current anthropological theories, the possibility of perception of climate changes in human societies that historically have collapsed, as well as those that are in process. We analyze critically the ethnographic cases presented in Jared Diamond's book Collapse, from the ecological theories and Tim Ingold's ecology of life. Our intent is to understand if the new ontologies proclaimed in those anthropological theories, which deny categories such as “misperception”, since perception is not supposed to be a vision of nature out there, but a практик resulting from different person–organisms in continuous changeable environment, can deal with the historical experiences of collective collapse.

P-2240-15
Cultural biases on climate change discourse – Findings on multinational survey in ICA-RUS Project
S. Munakata (1); Y. Fujigaki (2); E. Yagi (3); Y. Yamanouchi (3)
(1) Mitsubishi UFJ Research & Consulting Co., Ltd., Environment and Energy Dept., Tokyo, Japan; (2) The University of Tokyo, Tokyo, Japan; (3) Osaka University, Osaka, Japan

Climate change discourse tends to be framed by a particular set of values. There are different fundamental worldviews and perspectives jostling for position, and disagreement among the prescriptions for climate change can partly be explained by the underlying antimony. Nation--wide Web surveys were administered in 3 countries (Japan, USA and Germany). Respondents were questioned social value preferences relating to Mary Douglas’ grid and group theories, preference on mitigation target, and social value preferences relating to Mary Douglas’ grid and group. The results show a diversity of approach taken by reporters and are found in various topics (from a HAC). Between these two items, the media treatment of air pollution has been very limited compared to controversial issues around climate change, but the two are often related, sometimes not in a relevant manner.

P-2240-12
The media coverage of climate change and air pollution in French press
M. Madelin (1); S. Duchê, (1)
(1) University Paris Diderot, Sorbonne Paris Cite, Umr prodig, Paris, France

Climate change and air pollution has become two major concerns of the French, objects of issues, debates and therefore, recurring topics in the media. The study of a theme through its media treatment is rich and can illustrate the interface between scientific knowledge and perceptions. Through carrying out an analysis of the words and their associations, we can partly be explained by the underlying antimony. Nation--wide Web surveys were administered in 3 countries (Japan, USA and Germany). Respondents were questioned social value preferences relating to Mary Douglas’ grid and group theories, preference on mitigation target, and social value preferences relating to Mary Douglas’ grid and group. The results show a diversity of approach taken by reporters and are found in various topics (from a HAC). Between these two items, the media treatment of air pollution has been very limited compared to controversial issues around climate change, but the two are often related, sometimes not in a relevant manner.

P-2240-13
Dangerous climate here and now: Do our indicators let us perceive the signals? The 2003 heat wave in France
C. Mays (1); M. Poumadere (1)
(1) SYMLOG France, Research and consulting, Paris, France

Fifteen thousand persons died in the French episode of heat wave in August 2003, during the hottest summer in Europe since 1500. Yet it took months or years for this fact to be recognized. The heat wave dangers resulted from the intricate association of natural and social factors. Unusually high temperatures were combined with socio-economic attenuation, social attenuation of hazards – a multi-form inability of individuals and institutions to recognize that people were dying of the heat. The French experience confirmed research establishing that heat waves are a major mortal risk, number one among so-called natural hazards in postindustrial societies. Yet France in 2003 had no policy in place, as if dangerous climate were restricted to a distant or uncertain future of climate change, or to preindustrial countries. We analyze the heat wave’s profile as a strongly attenuated risk in the French context, as well as the causes and the effects of its sudden shift into amplification. Entrenched indicators can either mask or reveal the dangers of climate change. Improving indicators might be a significant lever in bringing about more sustainable behaviors.

P-2240-11
Now possible to attribute the fraction of risk caused by the emerging science of probabilistic event attribution to their livelihoods and to the overall sustainability of their farming system. This is the case of several areas of the Mato Grosso (Mt) state, Brazil, the second largest producer of agricultural products such as soybean, and sugarcane, and one of the most threatened by climate change. Approximately 70% of the surveyed areas of Mt, including the Chapada dos Guimarães in the Cerrado biome, have revealed stable rainfall levels between 1980 and 2010. However, when interviewed about climate change, the vast majority of family farmers pointed out the decrease of rainfall levels and suggested that this was the main reason for their economic losses at the farm level and a threat to the sustainability of their livelihoods.

In this regard, this project aims at understanding why so many family farmers wrongly attribute their loss of agricultural productivity to a decline in rainfall levels that has been mostly noted by meteorological stations, thus mal-adapting to the challenges that climatic change poses to their livelihoods and to the overall sustainability of family farming in the state.

How anthropogenic greenhouse gas emissions are changing the odds of individual extreme weather events – a communication opportunity

F. Otto (1) ; K. Haustein, (1) ; P. Uhe, (1) ; M. Allen (1) ; H. Cullen (2)
(1) University of Oxford, Oxford, United Kingdom; (2) Climate Central, Princeton, NJ, United States of America

Warming of the global climate system is unequivocal, predominantly due to rising greenhouse gases with direct implications from rising mean global temperatures for some slow-onset events such as sea level rise, which can therefore be linked directly to past emissions. In many regions, however, extreme weather events, like heatwaves, floods, and droughts, are associated with greater loss and damage. Increased average temperature can also lead to an increase in the frequency or magnitude of some extreme weather events including heat waves and droughts. For example, the deaths of at least thirty-five thousand people in Europe are attributable to the record-breaking heat wave of 2003. Extreme heat events and subsequent droughts can be directly linked to the loss of human life as well as damage to, or the significant diminishment of economic productivity.

The emerging science of probabilistic event attribution (PEA) has demonstrated over the last decade that it is now possible to attribute the fraction of risk caused by anthropogenic climate change to particular weather events and their associated losses. In other words, PEA enables us to give a quantitative estimate of how much anthropogenic climate change is costing us today.

This ability could potentially have a huge impact on climate change communication. Extreme events, in particular those that are not just rare from a meteorological perspective but also lead to societal and monetary damages and interrupt everyday life, usually receive a very high level of public attention. If attribution studies show that a particular event was indeed more likely due to anthropogenic climate change, i.e. anthropogenic climate change has increased the chance of the event occurring at this point in time, human induced climate change is transformed from something that is happening at some point in the future to a real threat in the here and now. Previously these studies took months to accomplish, delivering results long after public attention has peaked. Through a new partnership between Climate Central, a non-profit organisation providing TV weather attribution with climate information, the University of Oxford Environmental Change Institute and other academic partners this huge communication opportunity will be taken to the next level by building a modelling and communication framework that provides decision-makers, and in particular the public, with the means to make clear the quantitative connections between greenhouse gas emissions and extreme weather events in real-time.

This fast turnaround ensures that any communication opportunity will have maximum impact as an extreme event only remains topical while it is unfolding. By hearing the science as the public experience the event, they will really begin to fully understand climate change.
In India, climate change can represent additional pressure on ecological and socio-economic systems that are already under stress due to rapid urbanization, industrialization and economic development. With a rapidly increasing population, large and growing population, densely populated and low lying coast lines, and an economy that is closely tied to natural resources, India is considered extremely vulnerable to the adverse impacts of climate change, which requires exorbitant efforts on the part of respective communities to cope and adapt. There is a need to build a resilient community full of eco consciousness and mindfulness capable of changing and adapting to associated risk with psychological hardness and strong will power. For that, governments need to be aware of current and future potential risk and take more initiative in order to enhance the eco consciousness and resilience of the urban systems and communities. Co-adaptation is one such form of collective action whereby stakeholders of a community work together with a government agency to undertake some aspects of environmental issues which can be potentially threat full to the changing climate (Tompkins and Adger, 2004).

Socio psychological and spiritual factors play an important role in this regard to make serious efforts to modify and alter the life styles and behaviours of people in order to prove themselves as environmentally sensitive citizens across the planet, better suited to today’s environmental needs. Life style change also helped in developing human resilience to climatic variability in a more positive way than other efforts. Implications for psychological and Spiritual health were also discussed.

P.2240-21

Challenges to climate change adaptation: A case study on flood risk perceptions in the Hawkesbury-Nepean catchment, Australia

M. Shafaq (1)
(1) University of New South Wales, Institute of Environmental Studies, NSW, Australia

The Australian climate is characterised by extreme weather conditions. Future unpredictability has placed pressure on government agencies to increase their effectiveness of managing adaptation to extreme weather events, increase coordination and improve risk communication and community participation. Effective risk communication to climate change at different levels of government and among a wide-range of stakeholders require identifying and understanding the barriers that hinder adaptive action. The present study adopts a part of this level of research to flood management under a changing climate and intends to identify bottlenecks that create maladaptation. The research takes the Hawkesbury-Nepean catchment as case example. The catchment is characterised by ambitious development goals with higher levels of vulnerability to these stressors. Climate variability and change remain the most critical and as a flood-safe region. The outcome of this research is to provide a better understanding of communities residing in inland floodplains to contribute towards developing effective risk communication strategies thus enabling better management of floods and achieving increased level of support from the communities.

P.2240-21

Small Scale Peri - Urban Farmers’ Adaptation to Climate Change in Domboshawa, Zimbabwe

Vl. Tanyanyiwa (1)
(1) Zimbabwe Open University, Geography & Environmental Studies Department, Harare, Zimbabwe

Zimbabwe is a semi-arid country heavily reliant on regular rains (generally November to April). Rainfall exhibits considerable spatial and temporal variability characterized by shifts in the onset of rains, increases in the frequency and intensity of heavy rainfall events, increases in the proportion of low rainfall years, decreases in low intensity rainfall events, and increases in the frequency and intensity of mid-season dry spells. Extreme weather events, namely tropical cyclones and drought have also increased in frequency and intensity in the country. Agriculture is the main source of income for most smallholders. Farmers have to depend on rain, carry out crop cooling and livestock rearing in Zimbabwe. Adaptation of agriculture to climate variability and change impacts is vital for sustenance and food security. In order to develop appropriate strategies and institutional responses, it is important to have a clear understanding of the farmers’ perceptions on climate change adaptation at farm-level. Thus, this study identified, evaluated and suggested farm-level adaptation strategies to climate variability and change in Domboshawa; a peri-urban communal area located 26km north east of Harare, the capital of Zimbabwe. Domboshawa is located in Ward 4 of Goromonzi District in the Mashonaland East Province. Domboshawa is comprised of about 40,000 households with an average household size of 5 people and with more than 75% of these people relying on farming. The research design used in this study was both qualitative and quantitative (mixed method). The combination of both methods yielded more validity and reliability than using either method on its own. The study of climate change adaptation is focused on inquiry based on the description of experience and such studies adhere to a philosophical of understanding social phenomena which traditionally advocates for the use of qualitative and quantitative data. Simple random sampling was used to select 45 farm households out of the eight smallholder population registers from the Headmen of each of the five wards; Munyawi, Mawanga, Shumba, Murape and Pote were obtained which constituted the sampling frame. Each entity or individual was selected independently therefore ensuring that each entity had an equal chance of being selected from the three selected villages. Purposive sampling was used to select people or organisations that are experts in the area of interest. The questionnaire used in the Quantitative approach is the survey. Qualitative methods used include Participatory Rural Appraisal (PRA), specifically, resource mapping, historical trend lines, and seasonal and daily activity calendars. Focus group discussions and in-depth case studies were also used. Climate vulnerability and capacity which combines local and scientific knowledge will be used to elicit for knowledge that is local and scientific knowledge relevant to climate change. Findings revealed that local people perceived changes in rainfall and temperature based on their daily experiences. The majority of the smallholder farmers have adopted measures to address climate change and variability which include crop diversification, soil and water conservation practices, off-farm income activities and integrated crop and livestock diversification. The smallholder farmers have attempted to mitigate climate change and variability through planting drought resistant crops, constructing wells, setting irrigation schemes and engaging in agro-forestry farming activities by poor infrastructure, inadequate credit facilities as the farmers lack collateral and multifunctional input and output markets. Empirical analysis of rainfall surveys data during receiving rainfall trends between 1920 and 2008. The study concluded that there is need to educate farmers on climate change so that they are able to design adaptation strategies and organize the required level knowledge and practices on climate and water management so as to boost agricultural production. While there are multiple stressors that confront farmers, climate variability and change remain the most critical and exacerbate livelihood and intensity for those farmers with higher levels of vulnerability to these stressors. Climate
variability and change might also have a positive impact and localized benefits in the context of structural changes in community’s social organisation and economic activities under certain circumstances. There is need for agricultural research to support appropriate agricultural innovations and development of new livelihood activities emerging as farmers respond to climate variability and change.

**P-2240-22**

Public perception of climatic change and the risk control action of the government in metropolitan area of Belém, Brazil

S. Thomas (1) ; O. Almeida (2) ; CCC. Gena (3) ; S. Rivero, (4) ; VDA, Atila (5)

(1) Federal University of Pará – UFPA, Centre for Higher Studies on Amazon - NAEA, Belém, Pará, Brazil; (2) UFPA, NAEA, Belem PA, Brazil; (3) Federal University of Pará – UFPA, Economy, Belém, Pará, Brazil; (4) Federal University of Pará – UFPA, Institute of Social Sciences icsa, Belém, Pará; Brazil; (5) The Fluminense Federal University, UFF, Rio de Janeiro, Brazil

The extreme hydroclimatic changes such as floods, drought, soil erosion and collapse of river margins expose several negative impacts on the daily life of the population who live in the metropolitan city of Belem, in the Amazon region of Brazil. The characteristics of spatial occupation of the city favour the risk associated with these changes and the whole population is vulnerable to it.

The objective of this study was to analyse the perceptions of students of Federal University of Pará, Brazil (UFPA) about climate change risk caused by extreme hydroclimatic events in the metropolitan city of Belem and their vision about the Government action to reduce the risk caused by these extreme events. In addition, the research analyses public opinion in relation to citizens’ participation in decision-making and confidence in the ability of the State in risk governance.

The main hypothesis of this study is that the public opinion on the perception of problems related to extreme hydroclimatic changes is important for making public policies related to risk governance by the State.

This research employed the same structure of questions of Tien (2013)[i] used to evaluate the perception of risk in relation to climate change in Taiwan. The questionnaires were applied to all undergraduate students of economics from Federal University of Para, from the morning and night course during the months of May to June 2014.

In the perception of respondents about climate change, 78% think the importance of climate change is not exaggerated. Despite the accelerated industrialization and commercial farming are important factors for economic growth, 71% of respondents agree that combating climate change would be favourable to the Brazilian economy. More than half of respondents (51 percent) agrees that a possible implementation of environmental protection would facilitate the Brazilian economic development and 75% of the respondents disagrees with the permanence of oil subsidies.

About 62% of respondents are not willing to pay more taxes on clean energy and environment. It is noticed that the implication of social and individual memories should be considered as new method for policy makers, urban designers and social workers to understand the changing of natural environment and how this is impacting humanity.

Climate change has been presented as the great equalizer, one of those productions of the modern risk society that places all of humanity at the same disadvantage with respect to a calamitous future. Social studies of risk, however, paint a very different picture, showing that the adverse consequences of risk fall disproportionately on the most vulnerable segments of global society. How might the future of climate policy look if climate change were reframed in terms of the inequality of its short-term impacts rather than the potentially longer-term equalization of a world at risk? The talk focuses on the adaptation and mitigation of climate change as well as the role of international institutions in the process.

**A Sense of Place: Social Recovery in the Post-Disaster Reconstruction in Sichuan, China**

H. Wu (1) ; C. Hou, (2)

(1) Sichuan Agricultural University, School of Architecture and Urban–Rural Planning, Dujiangyan, Sichuan, China; (2) Sichuan Agricultural University, School of architecture and urban–rural planning, Dujiangyan, Sichuan, China

Climate change has been triggering frequent global environmental crisis. Those environmental crisis bring about a new method for policy makers, urban designers and social workers to understand the changing of natural environment and how this is impacting humanity.

Climate change and the Future of Inequality

S. Jasanooff (1)

(1) Harvard Kennedy School, Pforzheimer professor of science and technology studies, Cambridge, United States of America

Climate change has been presented as the great equalizer, one of those productions of the modern risk society that places all of humanity at the same disadvantage with respect to a calamitous future. Social studies of risk, however, paint a very different picture, showing that the adverse consequences of risk fall disproportionately on the most vulnerable segments of global society. How might the future of climate policy look if climate change were reframed in terms of the inequality of its short-term impacts rather than the potentially longer-term equalization of a world at risk? The talk focuses on the adaptation and mitigation of climate change as well as the role of international institutions in the process.
A new framing and a new governmentality order for the climate problem

A. Dahan (1)
(1) EHESS / CNRS, Centre alexandre koyrè, Paris, France

For the last 25 years, anthropogenic climate change has been framed as a global environmental pollution problem, which must be solved by reducing human greenhouse gases emissions through a global agreement negotiated under the auspices of the UN. The role played by sciences in the construction of the problem is essential, and is well summarized by the claim “science speaks truth to power,” with science and politics assumed to be hermetically separated. Although in reality this «linear model» is largely inadequate to account for the much more complex links between climate science and politics, notably within the IPCC, it has long been hegemonic, leading to debates focused on science rather than political responses.

This dominant framing has been undermined by the failure of major assumptions underlying international negotiations: it is now clear 1) that climate change is a geopolitical, economic, and development problem as much as an environmental one, 2) that we cannot solve it in isolation from all the regimes (energy, development, trade...) which perform the economic and financial globalization, and 3) that the needed industrial and social transformations have to be named and largely debated.

As the Paris CoP approaches, this paper critically examines the mistakes and the illusions of this framing, suggesting a new order of governmentality.

Carbon sink geopolitics: Using Science and Technology Studies to explore the futures of collective climate action

V. Ehrenstein (1)
(1) Goldsmiths– University of London, Department of sociology, London, United Kingdom

In the mid 2000s, as part of the international effort to decrease greenhouse gas emissions, the negotiation process on climate change started to look at how to reduce carbon releases caused by tropical deforestation – an item and forthcoming regulation referred to as REDD+. By drawing on Science and Technology Studies and a multi-sited fieldwork, which investigated the archives of climate negotiations and followed between 2009 and 2012 the problem of CO2 emissions assignable to tropical forest loss (from DRC’s Ministry of environment, to the 17 session of the Conference of the Parties and the international Europe-based offices of carbon experts), this presentation suggests using the case of REDD+ to explore the notion of carbon sink geopolitics as a potential learning opportunity for future climate actions.

The transformation of tropical forests into a carbon sink that should be taken care of occurred through diverse public and private interventions deployed in low-income regions (e.g. the Congo Basin), relentless scrutiny exercised by non governmental organisations on behalf of intact forests or the rights of indigenous people, research and commercial actors dedicated to measurement and quantification aspects, and lively debates within intergovernmental negotiations about the rules of a possible market-inspired mechanism. Such effort dedicated to preserve carbon sinks – or at least to make sure that the consequences of their exploitation (e.g. through logging or agriculture) do not go unnoticed – is still inscribed in the interstate and quasi-legal United Nations Framework Convention on Climate Change. The epoch is characterized by a radical geopolitics that the REDD+ process might be a precursor of and that this presentation proposes to sketch is an assemblage of, among other things, monitoring instruments like earth observation satellites, financial redistribution mechanisms like multilateral funds, and institutionally mobile actors like expatriate consultants and environmental activists. I argue that, while this geopolitics relies on the geographical and political order established by the United Nations, it develops in the interstices of such division, in inter-national spaces, where it creates a collective concern, the carbon stored by tropical forests, and its socio-technical community.

Politics of the Earth: Three Scientific Challenges in the Anthropocene

F. Gemene (1); B. Latour (2)
(1) Sciences Po, Politics of the earth, Paris, France; (2) Sciences Po, Medialab, Paris, France

It has been argued that the Earth had entered the Anthropocene since the industrial revolution. The Anthropocene is best described as a geological epoch where humans have become the driving forces of change on the planet. The epoch is characterized by a radical transformation of the relationship between humans and the Earth, of which climate change is one of the most evident transformations. It signals a new phase in the relations between a planet regulated by he laws of physics and biology, and human societies regulated by the laws of economics and politics. This transformation needs us to reconceive the scales and dynamics of collective action, to think together the World and the Earth.

“Politics of the Earth” is a new interdisciplinary programme
that seeks to achieve this objective. Its scientific perimeter is organised around two central dimensions, which depend on each other: a dimension of representation, and a dimension of government.

These two dimensions encompass thematic and methodological stakes, which can only be addressed through a common work between natural and social sciences. In order to think these multiple scales and dynamics, the Anthropocene imposes new representations, which are being made possible through the production of new data. Many of these data and databases, however, remain impossible to combine together, which prevents researchers from thinking the transformations of the Earth–World nexus in its multiple dimensions, and which also prevents an effective government of these new stakes.

The programme “Politics of the Earth” gathers research labs from different disciplines in different universities, around three challenges that crystallise the Anthropocene:

- Geopolitics of carbon dioxides;
- Expertise of risks and mediatisation of disasters;
- Dynamics of critical zones and urbanisation conflicts.

This session aims to present the preliminary results of the programme, which was launched in January 2015, and to show how these interdisciplinary perspectives can help represent climate change in the framework of the Anthropocene.

O-2241-05

Realising consilience. How better communication between archaeologists, historians and geoscientists can transform the study of past climate change in the Mediterranean

E. Xopilaki (1); A. Lzbekski (2); K. Holmgren (3); E. Weiberg (4); SR. Stocker (5); J. Luterbacher (1); U. Büntgen (6); A. Florenzano (7); A. Gogou (8); SA. Leroy (9); B. Martrat (10); A. Masi (11); AM. Mercuri (7); A. Masi (11); AM. Mercuri (7); MA. Sicre (14); M. Triantaphyllou (15)

(1) Justus–Liebig–University Giessen, Geography: Climatology, Climate Dynamics and Climate Change, Giessen, Germany; (2) Jagiellonian University, Institute of History, Krakow, Poland; (3) Stockholm University, Department of physical geography and quaternary geology, Stockholm, Sweden; (4) Uppsala University, Archaeology and ancient history, Uppsala, Sweden; (5) American School of Classical Studies at Athens, Athens, Greece; (6) Swiss Federal Research Institute WSL, Dendroecology group, Birmensdorf, Sweden; (7) Università di Modena e Reggio Emilia, Laboratorio di palinologia e paleobotanica, Modena, Italy; (8) Hellenic Centre for Marine Research, Institute of Oceanography, Anavissos, Greece; (9) Brunel University London, Institute for the environment, Uxbridge, United Kingdom; (10) IDAEA–CSIC, Barcelona, Spain; (11) Università di Roma La Sapienza, Laboratorio di palinologia e paleobotanica, Rome, Italy; (12) Istituto di Scienze Marine (ISMAR), Bologna, Italy; (13) UC–San Diego, Department of anthropology, San Diego, United States of America; (14) CNRS, LCEAN, Paris, France; (15) University of Athens, Faculty of geology and geovironment, Athens, Greece

This paper reviews the methodological and practical issues that have bearing on the ways in which geoscientists, historians and archaeologists collaborate in the study of the societal impacts of climatic changes in the Mediterranean basin. We begin with discussing the methodologies of the three disciplines in the context of the consilience debate, i.e. the attempts at unifying different academic disciplines, in particular from among the sciences and the humanities, that work on finding answers to similar questions. We demonstrate that there exists a number of significant similarities in the fundamental methodology between history, archaeology, and environmental sciences, due to their common interest in studying the past societal and environmental phenomena: this has to do, for instance, with the use of narrative structures as the means of communicating research results, which is common to the three of them. Consequently, we also present and compare the different narratives of the societal impact of climatic change that are characteristic of each discipline, which it is necessary to comprehend in order to engage in fruitful interdisciplinary exchange. Finally, in the second part of the paper, we focus our discussion on the four main practical issues that hinder communication between the three disciplines. These include terminological misunderstandings, problems relevant to project design, divergences between the publication cultures, and differing views on research impact. Among other recommendations we make, we suggest that scholars from the three disciplines should aim at creating a shared, hybrid publication culture, which should also appeal to a wider public, both within and outside of academia. Finally, we present possible actions on the part of both scientists and humanities scholars (archaeologists and historians) that – if taken – will solve several of the challenges discussed in paper.

2242 - Migration dynamics under current and future climate change

ORAL PRESENTATIONS

O-2242-01

Climate migration and the politics of causal attribution: a case study in Mongolia

M. Benoit (1)

(1) Wuhan University School of Law, Wuhan, China

Migration is always multi-causal. Ascribing a specific cause to migration, such as through the concept of “climate migration,” participates consequently to a political exercise, which puts into question the responsibilities of certain actors rather than others. This is the case, this article argues, regarding internal migration in Mongolia, whereby, during the last two decades, nomadic or semi-nomadic herders as well as inhabitants from small urban centres come to settle in insalubrious suburbs of the capital, Ulaanbaatar. The Mongolian authorities are keen to highlight changing environmental conditions that can be traced to climate change: a change in precipitation patterns and an increase of average temperatures contribute to cause large loss of livestock during harsh winters (dzud). Yet, a multitude of other factors concurrently influence the migratory behaviour of Mongolia’s nomads: unregulated and unsustainable pastoral practices, the insufficient provision of basic and support services in the countryside, or, more generally, the lack of public support to the agricultural sector. Identifying concurring causes of migration suggests alternative response measures, and this article argues that Mongolia should urgently rectify its development policies to provide a room for each of its citizens.

O-2242-02

How can migration support adaptation? Testing the climate change adaptation-migration nexus

J. Blocher (1); F. Gemene (2); N. Perrin (3)

(1) University of Liége, Sciences Po Paris, Liége, Belgium; (2) Francois.Gemene@uvsq.fr, Observatory of versailles–saint-quentin–en–yvelines, Guyancourt, France; (3) University of Liége, Cedem, Liége, Belgium

Empirical evidence shows that in the face of environmental and climate stress, migration is a common household strategy aimed at supporting basic needs and livelihood strategies (c.f. Foresight 2011). Policy makers commonly view adaptation measures as means to reduce migration pressures. But migration may also be seen as an adaptation strategy itself, as a way to reduce population pressures in climate-prone places while migrants already living outside
of vulnerable areas provide important resources to help communities adapt and respond to climate change.

However, the application of the environment and climate change adaptation–migration nexus has not been empirically examined, nor has the policy apparatus needed to deliver this potential been developed and assessed. More research is needed if policy interventions are to enhance the positive effects of migration on adaptive capacities and distinguish potentially maladaptive effects. The objective of this conceptual and methodological paper is therefore to flag different possible choices that can be made to study and represent the relationship between migration and adaptation, employing insights from a recently developed and tested survey instrument for the ‘Migration, Environment and Climate Change: Evidence for Policy’ (MECLEP) project.

The first section defines adaptation as it relates to mobility in the broad sense, taking care to anchor the potential of migration to build resilience and increase adaptive capacities within communities of vulnerable areas. It is then discussed what scenarios and research strategy, recently tested in at least three countries (Haiti, Papua New Guinea, Viet Nam) are brought to the fore. A final section weighs the challenges and advantages of the MECLEP approach and suggests what solutions may exist to advance the project and the field of research overall.

O-2242-03

Abrupt climate change superimposed to RCP 8.5 IPCC scenario: potential consequences for population migration

G. Ramstein (1); D. Defrance (1); C. Dumas (1); S. Charbit (1); J. Alvarez-Solás (2); F. Gemenne (3); JP. Vanderlinden (3)

(1) LSCE, Gif-sur-Yvette, France; (2) Universidad Complutense, Madrid, Spain; (3) University of Versailles–Saint-Quentin–en–Yvelines, Observatory of versailles–saint–quentin–en–yvelines, ceacr, Guyancourt, France

From Paleoclimate studies we know much more about abrupt changes as Heinrich events which are huge amount of icebergs periodically spreading over North Atlantic. These events occurred when the Laurentide ice sheet was unstable during glacial times. Recently, new mechanisms explaining what happened before have been developed to explain these instabilities [1, 2]. In contrast, Greenland and Antarcitca were more stable during last glacial/interglacial cycles. Ongoing global warming has also for consequence to make Greenland and West Antarctica out of equilibrium. Therefore, in future climate, new abrupt climate changes linked with surges from the cryosphere may happen again. To investigate this issue we built 3 scenarios corresponding to about 3 meter sea level rise: one melting part of Greenland, another one without West Antarctica ice sheet and last one is a mix of both. These scenarios are superimposed to RCP 8.5 which is the most pessimistic scenario within IPCC. They allowed us to discuss major climate changes, especially in regions with high population density (Monsoo areas).

We will first explain the methodology and the scenarios we used. These experiments have indeed, many common features with Heinrich events simulations in the past and housing experiments in the future [3]. Especially, the ITcZ shifts and associated migration areas but also sea level change in thermohaline circulation will be described. The consequences of such atmospheric and ocean perturbations will be also considered from a population migration point of view.

Most of the study focused on population migration only due to sea level rise, but here we developed an original approach using consistent climatic scenarios accounting for both sea level rise and induced climate changes.


O-2242-04

Unsettling Futures - Climate change, migration, and the immobility of climate politics

G. Bettini (1)

(1) Lancaster University, Lancaster, United Kingdom

The message that climate science and current emission trajectories are sending is clear: limiting global warming to 2°C is more and more an unlikely prospect. This predicament is hard to apprehend also because a 3 or 4°C warmer planet is a largely unknown place, where socio-ecological spaces and relations look differently. Visualizing the impacts of such severe climate change – and of our responses to it – requires a radical imaginative effort.

If we take the possibility of 3 or 4°C warmer planet seriously, we can expect changes in the very ways in which humans understand, plan and experience their (im)mobility. And in effect, the question of how climate change will influence human migration has alimented a florid debate in the last decade. Academics have written reams about climate-induced migration, and policy negotiations have gathered pace. To be sure, various steps forwards have been taken. The securitizing drives once ‘justified’ by the fear of mounting waves of climate refugees have given way to the resilience and adaptation strategy, reduced mobility (with the issue of ‘trapped populations’), voluntary migration (preached as a legitimate adaptation strategy), planned relocation and resettlement are co–protagonists of today’s policy debates. The environmental determinism of climate change is looked upon from a more comprehensive vista: displacement, reduced mobility is tackled by sterilizing the radical questions that might emerge. To the radical transformations associated to a 3 or 4°C warmer planet, the “new” discourses on climate-induced migration respond with ‘more of the same’, making sure that conciliate the agendas of dominant international agencies.

Nonetheless, there is a striking dissonance between the paucity of debates and the re–imaginary necesssary for formulating a politcized understanding of so called climate migration. While we should feel no nostalgia for the alarmist natures of the PNAS paper, mundane discourses anaesthetise the radical challenges posed by the climate–migration nexus. The prospect of unprecedented changes is dealt with through an attempt to reproduce "business as usual". The emerging discourses contemplate displacement, trapped populations, migration as adaptation and planned relocation in ways that conciliate the agendas of dominant international agencies. The current approaches to climate migration are a re–proposition of the measures predominant in the fields of development, aid, migration, risk management and climate adaptation, which have proved functional to the re–production of neoliberal relations.

In other words, the emerging discourses foreclose the potential of migrating by sterilizing the radical transformations that might emerge. To the radical transformations associated to a 3 or 4°C warmer planet, the “new” discourses on climate migration respond with ‘more of the same’, making sure that nothing can change even in the front of epochal changes.

O-2242-05

Potential Migration Impacts in Extreme Climate Change Scenarios: A Systemic Perspective

C. Zickgraf (1); P. Ozer (2); F. De Longueville (3)

(1) University of Liège / University of Reims Champagne–Ardenne, Center for ethnic and migration studies (cedem), Liège, Belgium; (2) UNIVERSITY OF LIEGE, Department of
environmental sciences and management, Liege, Belgium; (3) University of Liege, Cedem, Liege, Belgium

With the target of limiting global warming to 2°C becoming increasingly difficult to achieve, policymakers and other decision makers need to begin to plan for adaptation to changes in climate associated with higher levels of global warming. The HELIX project (High-End Climate Impacts and ExTremes), an EU FP7 project funded by the European Commission, seeks to provide a clear, coherent, internally consistent view of a manageable number of "future worlds" under higher levels of global warming reached under a range of physical and socio-economic scenarios. In this presentation, we specifically address how migration will fit into this picture. Assessing future migration under extreme climate change is not a facile task. Often predictions of massive future displacements are based on the numbers of people living in a risk zone, without taking into account differentiated vulnerabilities and capacities for resilience. Moreover, predictions of massive human displacement in the future tell us little about the character, scale, or destinations of these projected movements. Therefore, in one of the tasks of HELIX, a multi-disciplinary team seeks to appraise future migration based on empirical investigation into how people have historically and are currently responding to environmental changes.

One of the critical insights revealed through HELIX thus far is the importance of people’s perceptions of climate change in determining their migratory responses and intentions. Based on survey data from several West African countries, we compared populations’ perceptions of climate change with objective climatic data. This comparison showed that most West African people are affected by what is externally considered to be 'non-significant' change. These results highlight that populations increasingly perceive the 'system' (social, demographic, economic, environmental) in which they live becomes less and less able to resist different stresses, even those of limited magnitude. This finding has significant implications for migration: some of the surveyed people directly migrated in response to these changes and others plan to migrate if rainfall conditions worsen in the future. As people’s migratory decisions and intentions are based on their own perceptions of climatic changes and their ability to withstand them rather external risk/resilience assessments, an increase in migration could occur faster than previously expected in West Africa in the coming decades, calling for new policy responses that have to include the resilience capacity of the entire ‘system’.

Much like policy must address the decreasing systemic resilience of vulnerable populations, future climate change–related migration policies and approaches would do well to consider human (in)mobility responses from a systemic perspective. Interconnections are based on the numbers of people living in a risk zone, without taking into account differentiated vulnerabilities and capacities for resilience. Moreover, predictions of massive human displacement in the future tell us little about the character, scale, or destinations of these projected movements. Therefore, in one of the tasks of HELIX, a multi-disciplinary team seeks to appraise future migration based on empirical investigation into how people have historically and are currently responding to environmental changes.

Migration associated with large-scale land acquisitions, land tenure and land degradation

D. Gharbaoui (1); S. Vigil (2); N. Pearson (1)
(1) University of Liège, Cedem, Liège, Belgium; (2) Center for Ethnic and Migration Studies, University of Liège, Liège, Belgium

The proposed presentation intends to extend current debates on migration and climate change to emphasize the importance of land planning for environmentally–induced migration with a particular focus on large-scale land acquisitions, land tenure and land degradation. The panel will use a bottom-up approach to explore examples of local and regional case studies on migration dynamics associated to land management. The first case study will focus on the issue of land tenure in the Pacific regional context, the second will analyze the issue of large-scale land acquisitions in Senegal and Cambodia and the last case study will illustrate how land degradation could be a major challenge in the context of environmentally–induced migration in Burkina Faso.

The need to focus on land in the particular context of climate–induced migration is crucial as the Intergovernmental Panel on Climate Change (IPCC) emphasized in its fifth assessment report released in March 2014; past examples shows that environmental change can affect land rights and land use, and at the same time, change of land use has also become in turn drivers of migration. This is particularly relevant for the Pacific region where retreating from affected coastal areas through migration as an adaptive strategy to changes in environmental patterns has always been part of the Pacific Islands’ communities culture and practices. In the coming decades, the adverse effects of climate change in the region are likely to exacerbate both slow and sudden-onset environmental events threatening sustainable livelihoods and increasing the number of people to use migration as coping mechanism. However, there is a lack of study on land rights and land tenure systems that have been given little importance in the literary and policy debate on adaptation strategies in the context of Climate Change. It is crucial to address this dimension, particularly in the context of Pacific Islands, where in the majority of the countries, 80% of land is under customary tenure. Dalila Gharbaoui will study the role of land tenure in planned relocation exploring a sub–regional case study involving past examples of planned relocations in Fiji, Papua New Guinea and Vanuatu. A major difficulty with this type of research is the lack of academic and institutional evidence suggesting that environmental migration is a reality; what is harder to foresee is what forms it will take in the future. The project will assess future migration under extreme climate change, by presenting the complexity of the phenomenon and the multiple factors at play, and by examining the phenomenon in a more general context of uncertainties around local climate change impacts, around future demographic, social, and economic changes. This presentation will explore the difficulties around predicting future migration flows in the context of climate change, by presenting the complexity of the phenomenon and the multiple factors at play, and by examining the phenomenon in a more general context of uncertainties around local climate change impacts, around future demographic, social, and economic changes.

Predicting the social impacts of climate change: Migration, environment and climate change in a world of global uncertainties

D. Ionesco (1)
(1) International Organization for Migration, DMM/MECC, Geneva, Switzerland

The links between global environmental change and migration have been explored at length, and existing academic and institutional evidence suggests that environmental migration is a reality; what is harder to foresee is what forms it will take in the future. Will more people be forcibly displaced due to extreme climate change and natural disasters? Will more people resort to migration as a positive adaptation strategy in the context of climate change? Will people be able to migrate at all, or will they find themselves trapped in vulnerability?

This presentation will explore the difficulties around predicting future migration flows in the context of climate change, by presenting the complexity of the phenomenon and the multiple factors at play, and by examining the phenomenon in a more general context of uncertainties around local climate change impacts, around future demographic, social, and economic changes. This presentation will explore the difficulties around predicting future migration flows in the context of climate change, by presenting the complexity of the phenomenon and the multiple factors at play, and by examining the phenomenon in a more general context of uncertainties around local climate change impacts, around future demographic, social, and economic changes.
Another crucial study of land in the context of climate-induced migration focusses on the case of policies aiming at biofuel production incentivising the acquisition of large tracts of land in the Global South, often overlooking the rights of local populations and leading to the forced displacement of whole communities. Through an example of climate change mitigation policies leading to “green grabbing”, we can see how the multi-causal links between climate change, migration and displacement are far from being straightforward. The links with the category of environmentally-induced migration occur most visibly when such agro-fuel projects destroy the local land and the water resources, forcing people off their land in what could be seen as a form of tertiary displacement. Whilst those analysing the social consequences of land investments need to pay more attention to the migration outcomes, there is also a need for environmental migration scholars and practitioners to broaden the scope of their analyses. In order to better understand how the climactic agenda, through legitimising many recent land acquisitions has impacted local population movements in the context of climate change, a need for an inter-governmental process to address the challenges of cross-border displacement in the context of disasters and the effects of climate change.

**O-2242-08**

**Protecting the rights of people displaced and at risk of displacement**

NM. Birkeland (1)

(1) Norwegian Refugee Council, Partnerships and Policy Department, Oslo, Norway

Every year around the world, tens of millions of people migrate and are forcibly displaced by floods, wind–storms, earthquakes, droughts and other disasters. Many find refuge within their own country but some have to go abroad. In the context of climate change, such movements are likely to increase. National and international responses to this challenge are insufficient and protection for affected people remains inadequate. States and other duty bearers need to protect and assist people displaced or at risk of displacement by disasters and the effects of climate change. Assisting such people is not only a humanitarian imperative but can also assist in the long-term climate adaptation and development planning.

The impact of climate change is most acutely felt by individuals and communities with pre-existing vulnerabilities which often are characterized by the limited enjoyment of rights. Many of the most important protection challenges in disaster situations related to climate change are long-standing protection and human rights concerns which are brought to light by further exacerbation of the existing vulnerabilities, while people displaced within their own countries are covered by national laws, international human rights law, the Guiding Principles on Internal Displacement and a few regional instruments, such as the European Convention on refugees. People displaced by climate change (e.g. by sea level rise) from both Senegal and Cambodia addressing more deeply those questions.

**2242–POSTER PRESENTATIONS**

P-2242-01

**Environment and human migration in context of Climate Change: empirical insights from urban migrants in Ulaanbaatar, Mongolia**

S. Bilegsaikhan (1)

(1) Seoul National University, Department of Environmental Planning, Seoul, Republic of Korea

Global climate change and regional environmental changes resulting from the process are known to influence ecosystem–dependent populations relatively directly. Human mobility, particularly rural–urban migration under the changing climate, is one of such complex issues that is highly context specific. This nexus of climate change–environment–migration is gaining growing attention not only from climate change researchers but also rural and urban development policy makers in the recent decades. This paper presents a retrospective in-depth investigation of environmental factors of migration among urban migrants in Ulaanbaatar, who, before immigrating to the city, were traditional rural pastoralists in some of the most weather extreme prone regions in the country. Theorizing migration as one of possible adapting strategies taken by a household as a response to environmental changes, this study explores similarities and differences in forms of migration among households (vulnerable migration versus resilient migration), elements that have enabled successful migration (different forms of capital) and urban integration issues after settlement in the city. The study emphasizes on major occurrences of drought and drought-related winter disasters since a major socio–political shift in the country – democratization in the 1990s.

**P-2242-02**

**Small Island Developing States, Sea Level Rise and Migration: Exploring Sovereignty and Resource Rights in Abandoned Nations**

D. Carey (1); A. Fuentes, (2)

(1) University of Waterloo, Geography and Environmental Management, Waterloo, Ontario, Canada; (2) University of Waterloo, Geography and environmental management, Waterloo, Canada

Small island developing states face the world’s most vulnerable nations to the impacts of climate change. Countries such as Tuvalu face the very real risk of permanent abandonment with rising sea levels and a lack of financial resources to respond, i.e. aiming to prevent imminent or stop on-going violations, remedial, i.e. aiming to provide redress (e.g. access to justice, reparation or rehabilitation) for past violations, or environment-building, i.e. aiming at creating the necessary legal and institutional framework, capacity and awareness that is necessary to promote respect for human rights and prevent future violations. Those affected by the disaster and climate change thus become individual rights holders who can claim rights from particular duty bearers rather than simply being passive beneficiaries and recipients of charity.

Displacement in the context of disasters and climate change cause and worsen protection risks such as sexual and gender–based violence, family separation, child trafficking, unequal access to assistance, discrimination in aid provision; enforced relocation; loss of personal documentation; land disputes and issues related to land and property rights. In view of this protection gap, there is a need for an inter–governmental process to address the challenges of cross–border displacement in the context of disasters and the effects of climate change.

**ABSTRACT BOOK**

International Scientific Conference     7-10 JULY 2015    PARIS, FRANCE
laws of the high seas? To date, there is no legal answer to this question. To address these matters, as well as those of sovereign governing within a foreign nation, we propose that nations willing to host migrants work to establish a legal framework which mirrors the self-government agreements employed between Canada and First Nations populations. To make this relationship agreeable and beneficial to the host nation, we recommend that the government of the island set to be abandoned agree to provide a legal framework which mirrors the self-government agreements employed between Canada and First Nations populations. To make this relationship agreeable and beneficial to the host nation, we recommend that the government of the island set to be abandoned agree to provide a legal framework which mirrors the self-government agreements employed between Canada and First Nations populations.

P-2242-03

Changements climatiques et la Migration dans les régions de Mopti et de Sikasso

NP. Cisse (1) ; OK. Famagan (2)

(1) Institut Supérieur de Formation et de Recherche Appliquée, Faculté de Sciences Humaines et Sociales, Bamako, Mali ; (2) Faculté d’Histoire et de Géographie, USSG, Bamako, Fhg, Bamako, Mali

Cette étude a porté sur les communes de Dourou, dans le cercle de Kouto, et de Kourou, dans le cercle de Sikasso, en zone soudano-sahélienne, où les précipitations moyennes annuelles sont supérieures à 1 300 millimètres. L’approche méthodologique s’est appuyée sur une recherche documentaire, la réalisation d’enquêtes quantitatives et qualitatives.

Les résultats ont révélé que les populations des zones enquêtées ont une perception négative de l’évolution des facteurs climatiques, avec des conséquences diverses sur leur vie économique, sociale et culturelle. Dès lors, il est nécessaire de mettre en place des strategies adaptatives et de développer des politiques de développement qui tiennent compte de ces changements climatiques.

Les conséquences de cette pérégrination climatique sont multiples et diverses : diminution de la fertilité des sols avec pour corollaire la baisse de la production agricole ; diminution des ressources en eau (tarissement précoce des points d’eau et leur ensablement), diminution de la force du vent et des températures, hausse des températures et augmentation de la force des vents.

Face à ces effets néfastes des changements climatiques, les populations ont développé plusieurs stratégies d’adaptation dont l’organisation des départs des membres de la famille, à l’intérieur (exode rural) comme à l’extérieur (migration internationale).

Les résultats ont montré que la commune de Dourou, à l’instar du plateau Dogon, est une zone traditionnelle d’émigration qui a connu un exode massif à partir de 1990. Les migrations, observées au niveau interne dans la commune de Dourou, sont le fait d’une volonté manifeste d’accéder aux ressources encore disponibles dans la zone d’accueil. De même, dans la commune de Kourou, cercle de Sikasso (zone de forte immigration interne), une rétroaction négative lie cette immigration aux effets néfastes des changements climatiques sur les ressources naturelles. D’où de nouveaux départs des populations de cette commune vers les zones aurières et les grandes villes à l’intérieur du pays.

Les changements climatiques qui se sont amplifiés de 1970 à 1990, ont renforcé ces migrations internes. Comprendre le lien entre changement climatique et migration consiste à appréhender les facteurs d’accroissement de ces mouvements, pour pouvoir anticiper et mettre en place des stratégies d’adaptation efficaces.

En vue de minimiser les effets néfastes des changements climatiques et des flux migratoires, les populations ont développé certaines stratégies qui s’ordonnent les uns aux autres :

• Le développement des activités génératrices de revenus (AGR) ;
• La création de cantines scolaires dans les écoles pour diminuer la déperdition scolaire par la migration ;
• L’utilisation des semences améliorées plus adaptées ;
• La réglementation de la coupe du bois et le développement de bonnes pratiques de gestion des ressources naturelles pour fixer les populations sur leurs terres d’origine.

Mots clés : changements climatiques, migrations, vulnérabilité, stratégies endogènes d’adaptation.

P-2242-04

Climate change, human mobility and disaster risk reduction: The contributions of international law and pathways for implementation post-2015

A. Kron (1) ; S. Atapattu (1) ; K. Lofts (1)

(1) Centre for International Sustainable Development Law, Montreal, Quebec, Canada

Tens of millions of people are displaced each year due to natural disasters. As the frequency and intensity of natural disasters and slow onset events such as drought increase due to climate change, rates of migration are set to rise further.

The inter-relatedness of climate change and migration has been emphasised in academic scholarship and public policy for a number of years. At the 2011 Nansen Conference, the Special Representative to the Secretary-General (SRSG) on disaster risk reduction, Margareta Wahlström, noted in her capacity as Chairperson that “[c]limate change acts as an impact multiplier and accelerator to other drivers of human mobility”. Indeed, the draft negotiation text for a new instrument on climate change displacement coordination facility as part of the loss and damage section.

Disaster risk reduction (DRR) can also provide means to prevent displacement (e.g. through early warning systems), and to mitigate the effects of such displacement. As there is no UN organ dealing exclusively with migration, it is important that entities such as the United Nations Office for Disaster Risk Reduction (UNISDR) contribute to furthering displacement issues, particularly in regards to disasters, which account for the majority of those forcibly displaced around the globe.

The Hyogo Framework for Action 2005–2015 strives to promote a culture of proactive measures in regards to DRR. As the present Hyogo Framework will expire in 2015, UNISDR has been tasked with facilitating the development of a post–2015 framework for disaster risk reduction. Thus, a new Hyogo Framework will be adopted at the World Disaster Conference in 2015 and then put forward to the General Assembly. The Hyogo Framework is referred to in the proposed text for the Sustainable Development Goals, and SRSG Wahlström has also emphasized the importance of such cross-fertilization.

Scholars such as Elizabeth Ferris have proposed suggestions on climate change, resettlement and planned relocation, drawing upon e.g. the rules relating to development-forced displacement and resettlement. These considerations are partly reflected in the zero draft. For a new Hyogo Framework, which calls for “regular disaster preparedness exercises, including evacuation drills,” and in the negotiating text at the UNFCCC.

This presentation aims to examine the establishment and implementation of the new frameworks on DRR and climate change from an international legal perspective, looking specifically at the rights of displaced persons. A particular focus will be placed on internal displacement caused by climate change. First, this submission will analyse the existing obligations relating to migration and climate change, including voluntary mechanisms for human mobility and planned relocations. Second, it will cover methods of implementation, including good practices, monitoring, and the importance of reliable data. Lastly, it will feature some concluding remarks and potential areas for future research.


We study how climate affects migration decisions of households in Ghana and Nigeria. If migration is part of the present adaptation portfolio of households to different climatic conditions, it is reasonable to expect that it will also be an adaptation to climate change. Thus, we also provide estimates of the expected impact of future climate change on migration in Ghana and Nigeria.

It is important to stress that we are interested in climate --- the average of weather conditions over a long period of time --- rather than in short-term weather fluctuations, which represent single realizations of climate. Our approach accounts for the long-run adaptation response to climate. The existing literature has instead mainly focused on the relationship between weather variability as well as weather extreme shocks, such as flood or drought, and migration. Overall, this literature suggests that out-migration is a common response to agricultural productivity losses due to harmful weather events. The analysis of migration response to weather variation and shocks is a very interesting area of research but estimated elasticities should not be used to provide estimates of the response to slowly changing climate patterns.

In this paper we instead regress long-run migration patterns of households on climatic conditions and on other control variables. The advantage of this method is that it fully accounts for adaptation to the present climate. Migration is one of the many possible adaptations to local climatic conditions. The method thus identifies the relationship between climate and migration by exploiting the cross-section variation of climate and of long-run migration decisions.

What is the expected shape of the relationship between climate and migration? It is reasonable to assume that with less favorable climatic conditions the incentive to migrate increases. However, migration is an expensive investment and it may be too costly for some households. High temperatures and extreme precipitation patterns reduce agricultural productivity in the presence of agricultural adaptation for many reasons. However, migration is a costly investment. Climate change may increase the incentive to migrate but with incomplete and imperfect markets households may not be able to migrate because they may see a reduction in the very capital required to enable a move. Thus, given these different channels, working in opposite direction, the relationship between climate and migration decisions deserves an empirical analysis.

In this paper we narrow our focus on Ghana and Nigeria. The data are drawn from two different household surveys that gather individual as well as household information. We heavily draw on the predictions of the new economics of labor migration, introduced by Stark and Bloom (1985), which emphasizes the role played by the family in migration decisions. Migration of some individuals respond to an overall family strategy, designed to adapt to current climatic conditions.

Our results reveal that the relationship between the probability that at least one member of the household is a migrant and temperature in the dry season is hilly-shaped. A hill-shaped relationship results as well between precipitation in the wet season and migration. The highest propensity to migrate is at 23°C during the dry season and at 125 mm/month of precipitation during the wet season. This relationship holds only for households that are engaged in farming activities. The empirical findings reveal that migration decisions of non-farming households are not affected by climate. Our findings are robust to a series of alternative specifications. Households located in districts with mild temperatures/precipitations have a positive chance to become migrant families if temperatures/precipitations increase. On the contrary, in districts with already high temperatures/precipitations the positive sign reverts to negative. In this paper we instead regress long-run migration on economic determinants of incentives to migrate, and how climate change affected incentives to migrate in the past, how it affects incentives to migrate in the present, and what this may tell us about how climate change may impact incentives to migrate in the future. Our focus is on economic determinants of incentives to migrate, and how climate change alters these economic determinants.

To this we add a meta-analysis of the literature on climate change and migration, where we study the determinants of migration and climate change in the literature. We single out roughly 60 articles that look at climate change as a driver of human migration. In particular, we focus on the common issues of publication bias, and as to what kind of datasets and variables tend to be the most informative.
negative productivity shocks affecting the use of both capital and labor in the CGE model.

In order to build a reliable economic and demographic scenario at the end of the century, we rely on the projections of GDP and population provided by the International Institute for Applied Systems Analysis (IIASA) for the Special Report on Emissions Scenarios (SRES) A2 (Nakicenovic and Swart, 2000). We have two cases. In the first one the labor is completely immobile at the macro-regional level while in the second one we model an integrated global labor market. The migration process is entirely determined by the movements of workers who react to the relative wage signals induced by climate change.

The results show a world SLR economic loss around 2.64% of global 2007 GDP under the assumption of immobile labor and a SLR economic loss around 2.59% under the assumption of mobile labor. Table 1 reports results. Rest of Asia is the most affected region by SLR but interestingly some regions as China, FSU, SSA and MENA gain from SLR. Except Rest of Asia, Latin America and India all the regions are able to decrease their economic losses or to increase their gains when the labor is more mobile at the international level. We observe a migration process mainly from Rest of Asia to the other macro-regions. It is worth noting that we do not consider within-region migration.

All this suggests that the international migration driven by a more flexible and integrated global labor market could represent a useful adaptation strategy option to slightly reduce the economic impact of SLR even if it cannot substitute in any way the adoption of strong mitigation policy to trim down damages, especially in the Rest of Asia.

### Table 1

|       | % Produc-
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>tivity loss on labor and capital</td>
<td>% GDP change (labor mobility)</td>
<td>% GDP change (labor immobility)</td>
<td>Net migration flow (Millions)</td>
</tr>
<tr>
<td>OJ</td>
<td>-0.99</td>
<td>-1.05</td>
<td>-0.73</td>
<td>0.25</td>
</tr>
<tr>
<td>Chi</td>
<td>-0.79</td>
<td>1.24</td>
<td>2.13</td>
<td>9.57</td>
</tr>
<tr>
<td>Ind</td>
<td>-1.71</td>
<td>-2.66</td>
<td>-2.96</td>
<td>0.91</td>
</tr>
<tr>
<td>RoA</td>
<td>-4.88</td>
<td>-25.32</td>
<td>-30.48</td>
<td>-32.55</td>
</tr>
<tr>
<td>NA</td>
<td>-0.92</td>
<td>-1.22</td>
<td>-0.77</td>
<td>0.86</td>
</tr>
<tr>
<td>LA</td>
<td>-1.28</td>
<td>-4.19</td>
<td>-4.36</td>
<td>0.34</td>
</tr>
<tr>
<td>EU</td>
<td>-1.75</td>
<td>-2.74</td>
<td>-2.68</td>
<td>-0.75</td>
</tr>
<tr>
<td>MENA</td>
<td>-0.35</td>
<td>3.34</td>
<td>4.39</td>
<td>5.17</td>
</tr>
<tr>
<td>SSA</td>
<td>-0.27</td>
<td>4.11</td>
<td>6.16</td>
<td>13.43</td>
</tr>
<tr>
<td>FSU</td>
<td>-0.33</td>
<td>3.58</td>
<td>4.81</td>
<td>2.77</td>
</tr>
<tr>
<td>World</td>
<td>-2.64</td>
<td>-2.59</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

P-2242-08

**Ecological and social aspects of the Arctic zone of Yakutia, Russia**

N. Stepanova (1), G. Tuyara (1); N. Bochkarev (2)

(1) North-Eastern Federal University, Yakutsk, Russia; (2) Yakut Scientific Center, Yakutsk, Russia

Migration loss of population is characteristic for Siberia and Far East of Russia and is especially influenced Arctic zone. Number of population in Yakutia had shortened for 15% during 1990-2013, while in the Arctic districts of Yakutia – twice (for 53%). In 90-ies migration generally touched non-ingenious population who had migrated to other regions of Russia. Nowadays the internal migration prevails; people from the Arctic districts move to the ones with more comfortable climate and economic conditions and better jobs opportunities.

The fall of industrial production and quantity of population in Arctic had shortened the volume of pollution emissions caused by stationary sources in this area. In 1990–2009 it was reduced twice. In 1990 Arctic zone expel 21% of pollution emissions of the Republic Sakha (Yakutia), today it is only 12% of total mission in Yakutia. But because of the extremely low temperatures and massive permafrost occurrence the potential of Arctic nature to self-healing is low.

Today the main source of pollution is the living–support system, including heating system, transport, especially big vehicles which supplies Arctic zone with goods and fuels using winter roads. Housing and communal system in Arctic is characterized by high costs and low effectiveness, the huge disperse inhabited territory, isolated from the united energy supply system. Distances between populated localities in Arctic are about 600–700 km., heating period lasts from 223 to 365 days. Heating is organized by the low power disjointed boilers (with powers less than 2 Gkal/hour). These low efficiency boilers increase antropogenius environment pollution. Arctic districts heating system runs-out up to 80% and heat losses in the system are about 32%.

Arctic area deficits productive forces for neutralizing stationary sources' emissions. In Yakutia in general the level of neutralized pollution with regard to the level of its emission lowered from 75,9% in 1990 to 64,8% in 2009. While in the Arctic zone this figure started in 1990 lower, only with 15,7% and reached 6,6% in 2009. The same situation is observed in draining water downthrow: in Yakutia volume of draining downthrows is about 60%, while in Arctic zone there are now water cleaning facilities.

The decentralized energy systems modernization strategy of the North and Arctic zone focuses on the projects in alternative energy sources, automation of heating system. But nowadays it can hardly be implemented due to the limited access to the imported equipments and technologies, as well as to the local budget deficits. This situation can stay fixed for the several years.

Before soviet period Arctic was poorly inhabited territory with the extreme climate and poor food resources. This land cannot feed many people, and there were now huge settlements, people were spread over the territory for they can feed themselves by hunting and fishing. Thaw the antropogenius pressure was low. Beside innovation and new technologies usage for the Arctic development it is necessary to determine the quantity of population limits in this area. It will allow making decisions in economic and social policy in this area. It is probably necessary to move people from the depressive districts of Arctic zone to more comfortable once.
Coastal adaptation under high-end climate change

A. Sánchez-Arcilla (1) ; R. Nicholls (2) ; J. Hinkel (1)

(1) Universitat Politécnica de Catalunya (UPC), Maritime Engineering Lab. (LIM/UPC), Barcelona, Spain; (2) University of Southampton, School of civil engineering and the environment and tyndall centre for climate change research, Southampton, United Kingdom

The reduction of greenhouse gas emissions and the resulting level of global warming remain uncertain. The thermal inertia of sea water commits us to a continued increase of mean sea level at decadal to centennial scales. The increase of human pressure and economic development in coastal zones will aggravate the problem. Conventional hard coastal defences are costly and increase the risk of catastrophic consequences in case of failure and may exacerbate the loss of territory (e.g. wetlands) through coastal squeeze. Adaptation needs to be a long-term process covering a wide range of management strategies.

To face this challenge, advanced scientific information on the processes and impacts will be a key element in order to develop robust adaptation pathways. Such pathways must take into account plausible high-end sea level rise scenarios and changes in storminess as well as quantitative impact projections. This information will allow an objective definition of tipping points for adaptation, the effect of feedbacks between the various components of the coastal system and the efficiency of novel coastal interventions. The adaptation pathways will allow defining a sequential set of interventions that facilitate the maintenance of coastal zones under all climate scenarios. The role of novel solutions promoting natural accretion mechanisms and using eco-morphodynamics to reduce coastal mobility needs to be explored as this has the potential to increase our chances to maintain healthy coastal systems under a variety of climates. From here we shall derive advance information on when, where and how to act, especially if change is at the high end, and this will facilitate the sustainability of these areas.

Within the EU research project RISES~AM~ we are projecting impacts at global, regional and local scales. The global modelling is based on the DIVA code, addressing the hydro-morphodynamic processes at different scales. The regional modelling is based on a variety of hydro-morphodynamic models which reflect the site specific expertise and available model calibration/validation. As illustration for the Mediterranean we are analysing the Catalan and Croatian coast, the former with a sequence of models specially adjusted for this coastal sector and the second one with a regional adaptation of DIVA. The level of resolution and processes at this regional scale is much higher than for the global analyses, including surges, wave action and long shore and cross shore sediment transport components together with the human pressures and infrastructures existing along the coast.

The local dimension can be illustrated by the Ebro Delta and other small-scale Mediterranean deltas where both the vertical dynamics of the coastal plain and horizontal dynamics of the coastal fringe are being studied. For this particular case the suitability of “green” interventions based on promoting natural accretion is also being examined so as to assess its performance under present and future climate conditions. The resulting analysis will allow identifying and partially quantifying adaptation tipping points that will be presented in the paper. This will also be associated to determining critical thresholds as a function of scale and related by way of illustration to the availability of space or sediment. The combination of climatic pressures, coastal responses and the expected socio economic evolution will be the building blocks for defining an adaptation pathway suited to the studied coastal areas, illustrated in the paper by the three scales mentioned above.

Responding to Changes in Coastal Zones

N. Bednarsek (1) ; T. Klinger, (2)

(1) University of Washington, School of Marine Affairs, Seattle, United States of America; (2) University of Washington, School of marine and environmental affairs, Seattle, WA, 98105, United States of America

Changes in climate and associated stressors will impose critical changes in coastal ocean systems. We propose a session to address changes in the coastal ocean, using the California Current Large marine Ecosystem as a model system. The CCLME is a productive upwelling zone along the west coast of North America. It supports economically and culturally important fisheries and provides other essential ecosystem services. A large and growing population lives in the adjacent coastal zone. Climate and associated stressors are projected to influence circulation, productivity, and biogeochemical processes, including acidification and hypoxia, in the CCLME, with consequent effects on social and economic systems. In this session we will include perspectives that range from changes in physical and biogeochemical processes to those of ecosystem services and social and economic impacts that will close the session with a forward-looking perspective on collective action.

The Coastal Cities at Risk (CCaR) Project: Research advancing climate change adaptation planning and implementation in Metro Vancouver, Canada

L. Mortsch (1) ; G. Oulahen (2) ; K. Tang (2) ; Y. Klein (3) ; K. Damude (1) ; E. Joa (4)

(1) University of Waterloo, Geography, Waterloo, Ontario, Canada; (2) Western University, London, Ontario, Canada; (3) ACT, Simon Fraser University, Vancouver, British Columbia, Canada; (4) Simon Fraser University, Adaptation to Climate Change Team, Public Policy School, Vancouver, BC, Canada

Many low-lying coastal cities, already coping with population growth, urbanization and economic, social, environmental and cultural challenges, are increasingly exposed to climate change impacts related to rising sea levels and changing flooding risks. In order to respond to these challenges, proactive adaptation is becoming a fundamental and necessary response in a future that is likely to have increasingly frequent and more severe climate-related hazards. By understanding vulnerability and resilience, and their influence on adaptation planning and implementation, the capacity of these cities to address future climate change hazards and stressors can be improved. A Canadian–funded international research project – Coastal Cities at Risk: Building Adaptive Capacity for Managing Climate Change in Coastal Megacities (CCaR) – seeks to explore these issues in Bangkok, Vancouver, Lagos, and Manila. This presentation highlights results from Metropolitan Vancouver, British Columbia, Canada. It explores the unique challenges and opportunities in a complex urban environment that influence the effectiveness of adaptation planning and policy development. A variety of thematic areas related to this issue were addressed, including physical, economic, social, institutional, and health while employing a broad range of scientific approaches from natural, social science and applied engineering. This presentation highlights the social science component and the advances made in the social and institutional themes. Examples presented explore: the production of vulnerability to flood hazards, identitying indicators, and mainstreaming climate information. Multiple methods such as literature synthesis, focus groups, interviews, surveys and content analysis were used in combination with social vulnerability and resilience indicator development and mapping. The component on production of vulnerability to flood hazards applied a conceptual framework – across scales
and across actors – to identify and situate factors that influence vulnerability, mapped vulnerability indicators and “ground truthed” results with key stakeholders. Out of this research emerged an interest in developing resilience metrics, particularly examining how social resilience been developed in the climate change and hazards fields and what indicators have been developed for the neighborhood scale. From this literature review, an extensive list of metrics has been developed. The mainstreaming exercise involved workshops to assess how individual, sub-national and federal government policies facilitate or constrain the incorporation of climate change information into decision-making for adapting to flood hazards. In the paper, there was a strong commitment engaged with the community to access local information and expertise in order to ground the research but more importantly to initiate a two-way dialogue as a means of enhancing awareness and adaptive capacity. The process has contributed to building local adaptation capacity as CCAr research results have been incorporated into municipal adaptation planning and implementation.

K-2243-04

Title not communicated

O. Barreteau (1)
(1) IRSTEA, Umr geau, Montpellier, France

Abstract not communicated

O-2243-01

A Psychological Perspective on Behavioural Adaptation Challenges to Climate Change in Coastal Cities of India

R. Mudalair (1) P. Rishi (2)
(1) Aix–Marseille Université-CNRS, UMR ESPACE 7300, Aix–en–Provence, France; (2) Indian Institute of Forest Management, Bhopal, INDIA, Human Resource Management, Bhopal, MP, India

Coastal India faces a perceived potential threat owing to the vast sea–side development and huge populations in the vicinity of the coast. Climate change in coastal areas is associated much with flooding, SLR, land inundation, storms, cyclones etc. India has been identified as one amongst 27 countries which are most vulnerable to the impacts of global warming related accelerated SLR (UNEP, 1989). Therefore, there is a pressing need to address issues related to climate stress, adaptation, vulnerability and coping in coastal cities of India, especially from the psychological perspective. The established fact that anthropogenic factors account for one of the major contributors to climate change makes it necessary to probe into behavioral facets as in spite of the best possible efforts and initiatives, people may not give due importance to mitigate the impact. It is felt that people are still not as seriously aware/alarmed of the expected future risk as they should be. If environmental stressors persist chronically, they may lead to inner conflicts that can be psychologically disturbing for individuals and may even give rise to physiological, emotional, cognitive and behavioral changes.

In light of the above, the present behavioral study assessed the cognitive understanding of climate change, climate stress and actions and reactions of coastal people with a special focus on behavioral adaptation and subjective well being. This was conducted on a sample of 454 adults, both males and females (Age 18 years and above) in two coastal megacities of India namely Mumbai and Chennai keeping in mind the coastal hazards and vulnerability issues associated with these cities (TERI, 1996). Especially designed Climate change perception Inventory (CCPI) based on a four–point Likert type rating scale format was used to assess the respondents’ Climate change Awareness (CCA), Climate Stress and Emotional Concern (CSEC) Coping/Adaptation, Institutional Accountability (IA), and Coastal Subjective Well Being (CSWB). Results indicated a good level of CCA and subjective well being among coastal people. Respondents were found to be experiencing a moderate amount of climate stress and were unable to fully cope with it. They expected more efforts on the part of government and environmental institutions in adaptation with greater change in coastal cities and suggested various adaptive strategies in this regard. Results were interpreted in line with article 6 of New Delhi Work Program of UNFCCC (2007) in which special effort to foster psychological/behavioral change has been stressed through public awareness.

O-2243-02

First results from the world biggest coral planting program (Baa atoll, Maldives)

F. Ducarme (1)
(1) Muséum National d’Histoire Naturelle, Ecologie et Gestion de la Biodiversité, Paris, France

This work presents the first results of the world’s biggest coral planting program, located in Baa atoll UNESCO Biosphere reserve (Maldives), and led by SeaMARC / Marine Savers association, with scientific support from the MNHN.

Maldives is known as a very low island country, constituted of more than 1200 sandy islands not exceeding 2m high. This country shelters an extremely rich marine biodiversity along with a population of 400000 inhabitants. The frame growth, have been subjected to climate change in coastal areas on a biannual basis, and ~150 representative frames of different ages have been weighed in order to give a proxy for total biomass.

The Marine Savers program has started planting coral frames in 2007 and standardized the methods and gears in 2010, on the basis of a crowd founding system financed by resort tourists. More than 3000 coral frames have been planted to date at different sites and depths, totaling more than 200 000 coral grafts, from more than 20 different species of scleractinian corals. The frame growth, have been subjected to climate change in coastal areas on a biannual basis, and ~150 representative frames of different ages have been weighed in order to give a proxy for total biomass.

This study aims at providing a synthesis of these growth results and rate, along with observations on natural colonization by sessile, benthic and pelagic species. Results proved that this method can produce a substantial amount of coral biomass in a rather short time span, and recreate habitat conditions suitable for most reef species. Most coral species proved to be extremely site-sensitive, and show important growth discrepancies depending on slight condition differences.

Such experiment could help understanding growth and survival of different species of corals coastal under different conditions, and provide an important technical basis for further restoration or ecological compensation projects. As the frames developed by Seamarc are moveable, this system also aims at developing a way to help conserving young coral sprouts in deeper waters during bleaching events in order to achieve quicker and better ecological resilience, and in a longer run selecting the more resistant genes for climate change adaptation.

O-2243-03

Surviving from “rob” (tideal flood) – how local knowledge helps coastal villagers in Demak, Central Java

A.D. Ekaputra (1)
(1) Indonesian Institute of Sciences (LIPI), Research Center for Population, Jakarta, Indonesia

Indonesia is an archipelago country with coastline spans more than 90,000 km, the fourth longest in the world. The coastal areas house around 60% of the total Indonesia population. However, in the past few decades these areas has been threatened by increasing sea level rise, including Demak, a city located in the northern coast of Central Java. In 2010, Bedono, one village in Demak, suffered the most impact from ‘rob’ or tidal flood with half of the village area sunked into sea, including villagers’ residences. This has caused a significant number of local people lost their homes and livelihoods. With the insufficient guidelines on how to survive from ‘rob’, villagers forced themselves to adapt based on their own knowledge. A five-year research conducted by LIPI in Demak showed that villagers’ behavior to cope with the population of 400000 in the area, where houses are permanently drowned, villagers relocate to neighbouring villages. For other cases, villagers elevate their houses’ floors, reschedule time to cook, prepare
house cleaning utensils, and protect their children’s health. In the context of livelihood, villagers arrange the time to seed the fishpond so it can be harvested before tide comes and destruct the production process. One local knowledge that proves to be useful is silvofishery, integrating fishpond with planting mangroves. It has successfully decreased level of destruction in coastal areas as well as improving villager’s wellbeing. These adaptations based on local knowledge should be taken into account by the government to improve the climate adaptation strategies and programs.

Infrastructure and societal challenges in addressing climate impacts in the North Coast of São Paulo, Brazil

D. De Freitas (1); CDJS, Wilson (2); FMGD. Luiz (3)
(1) Technological Institute of Aeronautics, Department of water and environmental sanitation, São Jose dos Campos, Brazil; (2) Technological Institute of Aeronautics, Engineering division of infrastructure, department of water and environmental sanitation, São Jos e dos Campos, Brazil; (3) Federal University of São Paulo, Campus Baixada Santista, Oceans institute, Santos, Brazil

Worldwide, coastal communities are challenged by the increasing frequency and magnitude of natural events associated with climate variability and change. During the last decade, several significant events such as storm surges, cyclones and sea level rise have caused substantial damage to coastal infrastructure and communities. For example, continuous erosion and frequent storm tide inundation threaten coastal settlements and infrastructure by making them more vulnerable to landslides and flooding, respectively. These issues demand special attention in developing countries, where populous irregular settlements (such as slums) are common in coastal areas, experiencing greater vulnerability to natural disasters and other environmental risks. Nevertheless, climate change and its related impacts are neither well understood nor taken into consideration at local and regional planning scales in developing countries. Brazil is an example of such problem. At the local scale, there are pressures related to settlement for construction and operational assets associated with port expansion and the development of oil and gas industry mega-infrastructure. At the state and national scales, there are political and economic pressures imposed by development associated with the Pre-Salt oil exploration offshore which does not consider local management needs and priorities on land use issues. We present the findings of the Redelitoral, a multidisciplinary project with the objective of evaluating the knowledge climate change impacts effects on society, built infrastructure and land management, especially in areas experiencing fast development in the south-east of Brazil. Our results indicate that human settlement, mainly driven by tourism and mega-infrastructure developments, has induced urban sprawl towards the most vulnerable areas, making these populations and associated infrastructure more susceptible to the impacts of climate change. Fragmented and sectored licensing processes does not consider the cumulative and synergistic environmental effects resulting in inadequate public policies. Local coastal management initiatives show intense rearrangement, but changes are mostly focused in the ecological-economic zoning and creation of marine protected areas. Thus, climate change mitigation and adaptation strategies are not a priority in the planning agenda.

Climate Change, Biodiversity and Human Well-Being in the Coastal Communities around the Eko Atlantic City in Nigeria

AA. Akinwale (1)
(1) University of Lagos, Industrial Relations and Personnel Management, Akoka, Lagos State, Nigeria, Federal Republic of

With astronomical increase in the rate of urbanisation and deficits in environmental protection in Nigeria, coastal communities are at risk of the consequences of climate change, especially flooding, biodiversity loss, and food scarcity. This situation constitutes dangers to human well-being in the coastal communities in Nigeria. Therefore, this study examines human well-being in the context of climate change and coastal activities in coastal communities around the Eko Atlantic City in Nigeria, focusing on how the dangers of climate change can be mitigated with minimal discomfort to people and organisms in the coastal environment. The study is based on primary and secondary data in conjunction with the theoretical framework of political economy and underdevelopment. While extant literature and documents on climate change, biodiversity and urbanism in Lagos state, Nigeria constitute the secondary data, primary data were obtained via 20 Key Informant Interviews (KIs) and 8 Focus Group Discussions (FGDs) conducted in four Local Government Areas (LGAs): Apapa, Eti-Osa, Ibeju-Lekki, and Lagos Island, respectively. The KIs and FGDs involved youth and community leaders in several coastal communities in the selected LGAs. The discussions essentially dwell on the following issues: (1) the manifestation of climate change in coastal environment in Lagos state of Nigeria; (2) official efforts to mitigate the dangers of climate change in Lagos state; (3) consequences of land reclamation on biodiversity in the coastal environment; (4) public reactions to government’s efforts in the reclamation of lands and construction of Eko Atlantic City; and (5) how human well-being can be improved for achieving the goal of sustainable development in Lagos state. The findings reveal that climate change constitutes a threat to biodiversity and general socioeconomic development through extreme temperature, coastal erosion, frequent flooding, loss of land, increased salinity of water, which have become a recurrent environmental problem in Nigeria. To prevent further encroachment by the waves, the Lagos state government embarked on reclamation of lands and construction of a city project known as Eko Atlantic City through public-private partnership. The project is a 4-square mile extension of Lagos towards the edge of the Atlantic Ocean with a view to mitigate the problem of flooding through a 35-foot tall seawall protective barriers on the one hand, and the problem of growth by using the extension as a site for new apartments, on the other hand. Three out of every five participants describe the Eko Atlantic City project positively in terms of its strategic location and attractions. However, all the participants in the KI and FGDs expressed concerns over the policy failure by state government to take the well-being of the poor into consideration before and after the reclamation of lands for the construction of the Eko Atlantic City. There is consensus among the participants that only the wealthy persons and big industries have bought the lands reclaimed from the Atlantic Ocean. Two-third of the participants observes that land reclamation has created ecological imbalance and displacement of some communities and affected areas in Lagos state. The findings suggest that the Eko Atlantic City project is a form of internal colonialism which may be largely detrimental to human well-being in the coastal environment. Based on analysis of data obtained with adequate support from National and international environmental protection agencies the current situation in the coastal environment in Lagos state can be corrected through appropriate policies aimed at scaling up adaptation practice. Also, there is need for more attention on urban resilience systems to protect coastal communities in Lagos state from natural and manmade disasters.
data of 285 farm households in the cyclone and/or flood prone districts of Odisha, the present study identifies the farm-level adaptation measures as well the determinants of these measures: agricultural extension, access to Mahatma Gandhi National Rural Employment Guarantee scheme, relocation on a household level and informal credit. It is concluded that the government adaptation policies and investment options should take into account these determinants in order to enhance the adaptive capacity of small farmers in the cyclone and flood prone regions of the state.

P-2243-03

Integrating science into legal frameworks for sea-level rise planning - an Australian case study

J. Bell (1)

(1) University of Queensland, TC Beirne School of Law, Brisbane, Australia

One of the anticipated impacts of climate change is sea-level rise, with Australian communities likely to be particularly affected. It is estimated that 85% of Australians live within 50 kilometres of the coast (Department of Climate Change, 2009), making sea-level rise planning a major concern for Australian governments.

Despite this high level of risk, the inherent uncertainty surrounding the timing and extent of sea-level rise impacts makes it extremely difficult to garner political and public support for sea-level rise planning. Sea-level rise has been a politically divisive issue in Australia, with policies introduced by governments, and then removed following an election and shift in power to a more conservative administration.

This presentation will explore some of the novel approaches to incorporating science into legal frameworks for sea-level rise planning, and demonstrate how legal barriers have been overcome.

References:


P-2243-04

Planning for coastal relocation: analysis of relocation drivers in Hurricane Sandy affected communities

A. Bukvic (1); A. Smith (2); A. Zhang (3)

(1) Virginia Tech, Urban Affairs and Planning, Blacksburg, United States of America; (2) Virginia Tech, Statistics, Blacksburg, United States of America; (3) Virginia Tech, Urban Affairs and Planning, Blacksburg, United States of America

The future viability of some coastal communities has been severely challenged by the recent major disasters, as well as other episodic and chronic coastal hazards. These events also instigated a dialogue on their long-term resilience, adaptation options, and the possibility of permanent relocation from high risk areas. Little is known how exposure to disaster, in combination with other contemporary coastal challenges, affects willingness to consider relocation on a household level in highly-developed urban settlements. The main objective of this paper is to provide a bottom-up perspective on this dilemma via identification of demographic determinants and other disaster-related concerns that may influence support for relocation among coastal residents. More specifically, this study takes an interdisciplinary approach to examine the effects of pre-disaster socio-economic household characteristics, level of preparedness, disaster exposure, experience with recovery, concerns with other coastal stressors, relocation assistance support needs, community embeddedness, and resource loss on relocation decision-making. The findings hereby reveal that the willingness to consider relocation is primarily influenced by the age of respondents, disaster exposure level, economic resources, and informal credit. Specifically, as residents’ economic resources increased, being older no longer protected respondents from disaster-related stress or consideration of relocation.

The findings reveal that models which incorporate the interaction effects of variables in a novel way can yield results that are robust and robust to the inclusion of additional variables. These findings can inform the development of relocation policy that will more accurately reflect local circumstances and preferences and therefore receive more support for implementation.

P-2243-05

Paleoenvironmental changes of Heuksan Mud Belt (HMB) in the southeastern Yellow Sea, Korea

HG. Cho (1); KY. Kwak (1); C. Hunsoo (2); S.J. Lee (3)

(1) Gyeongsang National University, Geology, Jinju, Republic of Korea; (2) Korea Institute of Geoscience and Mineral Resources, Petroleum and Marine Research Division, Daejeon, Republic of Korea; (3) Korea Environment Institute, Environmental policy research group, Seoul, Republic of Korea

Quaternary paleoenvironmental changes of the Heuksan Mud Belt (HMB), a development stretching south to north along the southwest coast of the Korean Peninsula, are interpreted as having been mostly controlled by rises in sea level after the Last Glacial Maximum (LGM). This study investigates paleoenvironmental changes in the HMB through clay mineral changes in samples obtained from the Korean Institute of Geoscience and Mineral Resources (KIGAM) borehole, HMB-103 (core depth: 38.55 m), of 2012. Preferred—oriented specimens of 174 samples in 20 cm intervals were prepared and semi-quantitative analyses for 4 important clay minerals were then conducted using X-ray diffraction according to the Biscaye’s method (1965). Clay mineral contents within the clay portion of core deposits were, in descending order: 58.5–70.6% (avg. 64.5%) illite; 8.7–21.7% (avg. 16.0%) chlorite; 10.1–17.3% (avg. 13.2%) kaolinite; and 1.9–16.4% (avg. 6.4%) smectite. The deposits were classified into the following three units, according to the 4 clay mineral content: top—13.5 m (Unit I); 13.5–21.0 m (Unit II); 21.0–38.5 m (Unit III). Chlorite and kaolinite contents were higher in Unit III, while chlorite content decreased and smectite content increased from bottom to top in Unit II. The kaolinite content was similar in Unit II and Unit III, and showed a decreasing pattern with decreasing depth in Unit I. The content of illite was higher in Unit II than in Unit III, but had the lowest content in Unit I, where it showed a pattern of increase with decreasing depth. In general, illite and smectite had a negative relationship. The chlorite content was higher in the upper part of the drill core than in the bottom part, the smectite content showed the opposite tendency. The classification of units according to the clay mineral content is similar to the clastic content unit classification in geophysics exploration data. As a result of carbon age dating, the top part was found to be 2,700 cal yr BP, and the bottom part 50,000 cal yr BP, showing a range of 4500 years during the last LGM and current interglacial period. Before LGM, the sea level was low, and sediments with a high smectite and a low illite content flowed in from the south of the research region where the deposits of well-developed clay minerals as the sea level rose and the coastline moved to inland. Sediments with lower smectite and higher illite were then supplied from Korean rivers. It is also supported by the form of uppermost sediment exposed in the west. The deposit rate of the core deposits before LGM, which occurred 18 kyr ago was 2.07 m/kry, for the period 18–11 kyr it was 4.9 m/kry, and following the last glacial 11 kyr ago it was 3.35 m/kry. Such changes represent deposit rate changes according to the rise in sea level. The
Failure of Resilience & Adaptation in Agricultural Practice and Alteration of Socio-Ecological Structure Due to Ocean Acidification in 3 States of India

B. Chosh (1)
(1) Asian Marine Conservation Association, Coastal Agriculture, Kolkata, West Bengal, India

‘Climate change’ is the major point of discussion of any political & decision-making agenda of any nation in general, and intergovernmental meetings and summits in particular. World community now understand that because of world’s development sustainability depends upon all the ‘key-factors’ that significantly play into various thrust areas, like growth in agriculture, education and industry, and their respective drivers.

The problem of changing climate that reflected into adversities primarily into agriculture, education and industry has already been satisfactorily been identified by many researchers from academia, but not having the direct solution available, as of now, the policy makers have therefore to depend on some approach -- more of theoretical, than ‘straightforward practical’. In this premises, the concepts like ‘resilience’, ‘vulnerability’ and ‘adaptation’ have come into play.

This paper shows how resilience and adaptation fails in agricultural practices in and nearby coastal areas of 3 States (West Bengal, Andhra Pradesh and DIU-U.T.) of India, due to lowering of pH (Ocean Acidification) in nearby estuarine and coastal water increasing the ‘vulnerability’ in the socio-ecological structure that also have altered the pattern of local economic activities like ‘tourism’ and ‘fish drying industries’.

Local government responses to sea level rise in Metro Vancouver

D. Harford (1)
(1) Simon Fraser University, Adaptation to Climate Change Team, Public Policy School, Vancouver, BC, Canada

Attention to climate change and sea level rise has intensified in recent years in Metro Vancouver. The region has been identified as one of the top cities in the world with assets at risk from rising seas, and vulnerabilities in the region include municipal property and infrastructure, and agricultural lands, as well as transportation infrastructure that supports the region’s position as a gateway for global trade including railways, roads, port facilities and the international airport. Despite dense settlement and more than a century of industrialization, the region continues to sustain rich aquatic and terrestrial biodiversity, but climate change and approaches to adaptation also threaten ecosystem services. Experts have identified the need for regional collaborative governance to address climate change impacts, across the xx municipalities in the region, and four levels of government (local, provincial, federal and First Nations). There is a clear need for alignment of objectives among neighbouring coastal areas – without this, efforts undertaken in municipal silos could increase the risks.

In November 2012, nine local governments and organizations from Metro Vancouver, BC’s Lower Mainland already leading in climate change adaptation work took part in a workshop on regional approaches organized by West Coast Environmental Law and ACT. Sea level rise was identified by participants as the most critical issue requiring collaboration, and WCEL/ACT moved to facilitate the formation of the Metro Vancouver Collaborative on Sea Level Rise (MVC-SLR). MVC-SLR is designed to add capacity to these entities given a common lack of resources and the challenges of data gaps. Seven local governments are now working together to share scientific resources, risk assessment methodologies and implementation approaches. Additional priorities include understanding legal risks and seeding broader regional collaboration, across other levels of government and sectors. A provincial representative has recently joined the collaborative, and the SLRC has a pilot project underway demonstrating green approaches to coastal resilience.

Eco-technological management of atoll island against sea level rise

H. Kayanne (1)
(1) University of Tokyo, Department of Earth and Planetary Science, Tokyo, Japan

Atoll island countries comprise low, flat islands consisting of calcareous sand and gravel formed from coral and foraminifera. The islands are maintained both by the physical processes of sand transportation and sedimentation and by the ecological processes of biological production. In the past, the inhabitants maintained their islands wisely in accordance with geo-ecological processes, such as the conservation of coral reef ecosystems, sandy beaches, and coastal vegetation, and cultivated taro using fresh water lenses formed in the island sediments. At present however, the population concentration on the capital islands has led to inappropriate land use, degradation of coral reef ecosystems, destruction of geo-ecological processes through the construction of landfill sites and seawalls, and reduction in and deterioration of water resources due to the effects of over use and sewage. All these ‘local’ problems have disrupted sand production–transportation–sedimentation process.

The submergence and inundation of atoll islands are regarded as a result of sea levels rise. However, the present problems are not as simple as submergence caused by rising sea levels. Indeed, they are induced mainly by local problems. These problems have reduced the resilience of the atoll islands as historically maintained by their inhabitants.

«Global» issues also degrade coral reefs. Bleaching induced by global warming and ocean acidification resulting from increased CO2 also degrade coral reefs. ocean acidification reduces sand production. The modulation of El Niño, drought, and intensified typhoons induced by global warming threaten water resources in these islands. The problems in atoll countries involve inter-related local and global problems. Plans to adapt to global changes based on a simple scheme may instead reduce the resilience of these islands. To maintain the sustainability of islands against future global change, it is necessary to regenerate geo-ecological processes by removing local problems so as to construct highly resilient islands.

To regenerate coral and foraminifera production, ecosystem rehabilitation is necessary. This should be achieved by improvement of coastal environment by sewage treatment and waste management. Rehabilitation would be supported by foraminifera reef culture and regeneration of coral reef ecosystems, and the transplantation and their habitat generation, however, improvement of coastal environment is a prerequisite. Sand transportation and sedimentation processes should be re-established. An open-cut would enhance sand delivery from the ocean to the lagoon, nourishing littoral areas. Removal of the jetties or their reconstruction and the construction of artificial beaches will enhance sand supply to the ocean. Beach nourishment is proposed as a shorter-term coastal protection and rehabilitation plan that enhances but does not conflict with the long-term sand beach rehabilitation.

Yet, the local problems themselves originate from the globalization of the economy and society. In traditional
island societies, the inhabitants kept their islands robust, albeit poor economically, by means of local governance indigenous to each island. However, the globalized economy and society, together with the introduced Western political system, have led to the centralization of the population on the main islands and to inappropriate land use.

Without considering the background factors, island management programs will never be acceptable for island societies in terms of sustainability unless they consider the appropriate geo-ecological processes. Moreover, geo-ecological processes differ with geographical, climatological, and biogeographical variation; island governance differs according to historical and cultural background; and the expression of local problems depends on the local economic and societal background. Therefore, resilience and governance must be constructed in accordance with this geographical variation.

Unpacking the Co-production of Knowledge in Adaptation to Climate Change: The Role of Local Knowledge in a Coastal City – Tainan, Taiwan

HC. Lee (1); R. Chen (2)
(1) National Central University, Chung Li, Taiwan; (2) Chinese Culture University, Taipei, Taiwan

As most of climate change research initiatives are more focused on natural sciences, it is almost impossible to understand the Earth system without addressing how it as influencing the planet and as an essential driving force shaping the future of Planet Earth. Thus, a major new step has taken to the development of science – from disciplinary to interdisciplinary, from one sector to cross-sectoral, and from natural sciences to social sciences and the humanities.

Based on the research results from a 3-year (2013-15) core research program – Taiwan Climate Change Adaptation Technology (TaiCCAT), this paper takes an interdisciplinary approach by examining the role of local knowledge in policy relevant contexts. It targets local adaptation strategies in Tainan, Taiwan. Selected by Lonely Planet and Michelin as a must-see three-star tourist destination, Tainan, at the same time, has been at risks of rain storms and mud slides at mountain regions, urban flooding and coastal sea-level rise. Policy responses like building dikes or not, opening or closing water gates, water distribution among industrial, agricultural and residential sectors are frequently made by relevant government authorities with inputs from community groups.

To ensure government, business, society and academia have the foresight, knowledge and tools to adaption to climate change, this paper further conducts in-depth interviews with stakeholders from mountain, rural, urban and coastal regions for cross-checking its research findings. These interviews are employed in the next step of early engagement, trust-building, involvement of all stakeholders and assessment of knowledge needs and knowledge exchange. Hopefully in the future, it may become a robust example for co-design, co-production and co-delivery of knowledge also consistent with and called for by Future Earth research initiative.

Why urban poor exposed to climate change in coastal Bangladesh are more concerned about ecosystem disservices than services?

MM. Saroar (1) ; N. Fatema, (2)
(1) Khulna University, Urban and rural planning discipline, Khulna, Bangladesh; (2) Khulna University, Development studies discipline, Khulna, Bangladesh

Urban poor get numerous benefits from ecosystem services. Roles of urban ecosystem services in the wellbeing of urban poor are extensively discussed, yet little is known about the vulnerability of urban poor to ecosystem disservices. Particularly in the context of climate change some of the ecosystem disservices might seriously affect the urban poor’s wellbeing by impacting their livelihood, security and comfort. Therefore, this research is aimed to answer the question why some urban poor are more concerned about getting protection from ecosystem disservices than getting benefits of ecosystem services? Accordingly three objectives are framed. First, to identify range of urban ecosystem services and identifying the extent to which the urban poor take into account to ensure their wellbeing. Second, to examine whether urban poor really care more about protecting them from ecosystem disservices than taking advantage of services. Finally, to identify the factors that determine urban poor’s differential preference for ecosystem services/disservices.

This study was conducted taking coastal Khulna— a metropolis exposed to climatic disasters, as a case. Empirical part of this study was done in a large low-income settlement, named Rupsha slum. Family heads of a total 235 households were interviewed through administering a semi structured questionnaire. From a list of 25 ecosystem services and disservices, respondents were first asked to rate in a 5-point Likert scale (very low = 1 to very high = 5) if they get benefit from/affected by a particular ecosystem service/disservice. Second, they were asked to rate by using the same scale (a) the importance of those services and (b) their concern against those disservices. By employing Principal Component Analysis (PCA) on their responses to first question, the 25 categories were bought down to four practical utilities/negative utilities. These four categories are related to (a) livelihood, (b) comfort, (c) security and (d) recreation. For the second question, each person’s responses (denoting both importance & concern) were first summed up and later dichotomized taking median as the cut-off point. With this, the respondents were reclassified into two distinct groups: (a) low benefit seekers vs high benefit seekers from ecosystem services, (b) low concerned vs high concerned about ecosystem disservices. Taking each of these two groups as dependent variable, two Ordered Probit models were developed to identify the factors that influence the respondent’s positive preference (expressed earlier as “importance”) and negative preference (expressed earlier as “concern”) towards ecosystem services and disservices respectively. As independent variables, in addition to variables that are identified in相关文献, some more variables like: socio-economic, demographic, spatial and governance related aspects were employed in the Probit models.

Initial result shows that the urban poor take into account both green and blue ecosystem services for their wellbeing with a varying combination though. Variability is rather less as regards gaining advantage from various green ecosystem services such as green parks, streetscapes, urban forests, etc. as playing grounds. However, high variability is observed in regards to their concern over ecosystem disservices, particularly derived from blue ecosystem services such as rivers, canals, urban swamps, natural drainage. Ecosystem disservices such as green parks, streetscapes, urban forests, playgrounds, flooding, waterlogging, storm water overflows, surface run off and smell from decomposed waste. Probit models’ results show that importance of ecosystem services to respondent’s wellbeing are significantly determined by age, occupation, education, distance from house, access fees etc. On the contrary respondent’s concern over ecosystem disservices are significantly determined by gender, occupation, education, distance from house, access fees etc. However, other factors have limited influence. The findings would help designing appropriate interventions for (a) enhancing urban poor’s access to ecosystem services, and (b) protecting urban poor from the vulnerability of ecosystem disservices. Therefore, this finding would give synergies to ongoing efforts of building resilient urban community in the context of changing climate.

Social Memory and Social Change in a Portuguese Natura 2000 Coastal Area: Understanding Communities’ Adaptation to Climate change

E. Seixas (1); P. Castro (2); M. Carla (1)
(1) CIS—IUL, Lisbon, Portugal; (2) ISCTE—IUL, social psychology, Lisbon, Portugal

This presentation analyzes how social memory is linked to social change and climate change (CC) adaptation
in a Portuguese Natura 2000 coastal area of fishing importance. This book takes residents’ narratives and gives particular attention to those of fishers. Narratives are fundamental for linking the past, the present and the future, as well as for constructing meanings and identities. The priorities of coastal communities in Patuakhali area reveal that CC adaptation tell about the past are thus important for legitimizing specific social representations of the changes required for CC adaptation (e.g., representations of the new laws and regulations) and for legitimising other, alternative, representations, and it is important to understand them and their role.

The study draws on (n=24) in depth qualitative interviews and walking interviews with residents of a Portuguese Natura 2000 Southern coastal area (n=16 interviews with fishermen). The guiding research questions are: How do residents’ narratives about the past make sense of current social change and contribute to coastal CC adaptation or make it difficult? How do resident’s narratives about the past legitimize specific social representations of bio-conservation laws and of coastal trades and practices, in particular those linked to fishing? What can the particular ways in which residents’ narratives link the past the present and the future tell us about identity and representational processes, and about how these are affected by power differentials?

The preliminary analysis of the interviews suggests that (1) perceptions of a decrease in the main resources (fish and shellfish), (2) technological innovation and (3) the introduction of new legislation restricting fishing activities in Natura 2000 have created a series of tensions leading to a change in identity and representational processes, with consequences for power relations and social cohesion. These tensions evidence several representations of discontinuity with the past, differing types of social change evoked: (1) change induced by a decrease in the ‘resource’ (2) change induced by technological innovation and (3) change induced by the introduction of new legislation and other social/economic policies.

In the interviews with the fishermen, the claims that the resource has decreased are linked to claims that in the past theirs was a much simpler trade, since they could always count that there would be more fish available to catch the next day. Conversely, in the present, fishermen claim to have to rely much more on their knowledge and experience, which is an indication of increasing individual competition within the trade. They link the decrease in the resource to several factors like pollution, technological advances and, although not often, also excessive fishing. Technological innovation is described in a conflicting way: as an opportunity for increased income and savings. Improvement of physical capital such as brick-built housing structure is a common strategy found among better off fishers. Fishers are also found to plant trees around their house to get protection. In response to increased salinization of ground water, fishers harvest rainwater. In case of long-term adaptation, fishers put utmost importance to secured future of next generation and want to educate their children so that they can be able to leave risky professions and vulnerable place. The government support is not enough to increase the adaptive capacity of the people due to insufficient structural protection and a lack of enforcement. A number of suggestions elicited from fishers’ perception for effective tackling of climate change related vulnerabilities that includes construction of more cyclone centres having effective infrastructure and communication system, construction and repairing of embankment, mangrove afforestation to protect embankment, public private partnership for climate protection such for coastal afforestation, starting of rationing of food support, mobile banking system for cash support, training to improve skills for alternative employment opportunities to reduce pressure from fishing, disaster management training, checking corruption and people again introducing risk allowance for law enforcing personnel and other governmental officials during disasters rehabilitation, recruitment of trained graduates having deep knowledge on coastal resource and disaster management tools, mobile boats, helicopter rescue system from fishing place, wireless network or specialized software response system for early warning of disasters.

P-2243-13

Harvesting energy: People’s place-based perspective on mitigating climate change with renewable energy technologies on the German North Sea Coast

D. Süsser (1) ; M. Döring, (2)

(1) Institute of Coastal Research, Helmholtz zentrum Geesthacht, Human Dimensions of Coastal Areas, Hamburg, Germany; (2) Institute of Geography, University of Hamburg, Hamburg, Germany

Discussions on mitigating climate change revolve around the question of how to enable low-carbon energy transitions based on renewable energy technologies such as wind or solar energy. Communities and individuals have increasingly been recognised in public and policy for making an important contribution to sustainable energy transitions. This includes the role of places to which people feel attached to (Devine-Wright, 2011). A discrepancy is still remaining between the general openness to ecological ways of generating energy and the local resistance against the implementation or extension

P-2243-12

Coping with climate change impacts: The case of coastal fishing communities in Patuakhali region, Bangladesh

AR. Sunny (1) ; MM. Islam (2)

(1) Sylhet Agricultural University, Department of Coastal and Marine Science, Sylhet, Bangladesh; (2) Sylhet Agricultural University, Department of Coastal and Marine Fisheries, Sylhet, Bangladesh

Globally, Bangladesh is considered as one of the most vulnerable countries to the anticipated impacts of climate change. Following that situation, scientific community offers to test cases like Bangladesh to design different social change impacts and respective adaptation strategies in different professional groups. However, very few studies focused on the coastal fishing people, though they are among the most vulnerable professional groups to climate change impacts. Based on a fieldwork in four fishing communities in Patuakhali region of Bangladesh, this study identifies livelihoods strategies that fishers adopt to cope with the impact of climate change on them and possible ways to enhance their capacity to make climate resilient fishing communities in Bangladesh. To collect empirical data, household survey was conducted and a number of qualitative tools such as interview, focus group discussions, and oral history were employed. Coastal fishers in the study areas suffer from a number of climate changes related events such as cyclones, tidal surges, and saline water intrusion. Combination with high frequency of natural disasters, weak economy and acute poverty make fishing people very vulnerable to any shocks. In response to multi-faceted vulnerabilities, fishers adopt a number of strategies in considering long-term sustainability of their livelihoods. Immediate aftermath of the any disaster, fishers are found to survive depending on personal savings, relief from government and NGOs, taking loan from NGO and bank. Fishers (money lender) are the only way for the community to increase income and savings. Improvement of physical capital such as brick-built housing structure is a common strategy found among better off fishers. Fishers are also found to plant trees around their house to get protection. In response to increased salinization of ground water, fishers harvest rainwater. In case of long-term adaptation, fishers put utmost importance to secured future of next generation and want to educate their children so that they can be able to leave risky professions and vulnerable place. The government support is not enough to increase the adaptive capacity of the people due to insufficient structural protection and a lack of enforcement. A number of suggestions elicited from fishers’ perception for effective tackling of climate change related vulnerabilities that includes construction of more cyclone centres having effective infrastructure and communication system, construction and repairing of embankment, mangrove afforestation to protect embankment, public private partnership for climate protection such for coastal afforestation, starting of rationing of food support, mobile banking system for cash support, training to improve skills for alternative employment opportunities to reduce pressure from fishing, disaster management training, checking corruption and people again introducing risk allowance for law enforcing personnel and other governmental officials during disasters rehabilitation, recruitment of trained graduates having deep knowledge on coastal resource and disaster management tools, mobile boats, helicopter rescue system from fishing place, wireless network or specialized software response system for early warning of disasters.
of RETs in the form of NIMBYism (Devine-Wright, 2013a). Considerable research has been undertaken to better understand resistance against RETs while – so far – it has not sufficiently been investigated of how place attachment positively or negatively contributes to individual and collective resistance against implementation processes (Rogers, 2003). The paper takes this gap in research as a starting point and presents a socially embedded perspective by drawing on recent research carried-out in the area of place attachment (Devine-Wright and Devine-Wright, 2013) and locally embedded entrepreneurship (Audretsch, 2011; Feldman, 2010). Our study is based on qualitative interviews undertaken with inhabitants of and a standardised household survey in the coastal municipality Reußenköge (North Frisia; Germany) in 2014 and 2015. It represents a rural area in which grain production and harvesting fields were the main agricultural practices due to historically reclaimed fertile marshland. This situation however, changed with advent of onshore wind energy at the end of the last century and solar energy and biogas at the beginning of this century. In due course, the coastal municipality of Reußenköge developed from a transportation corridor into a so-called model-region for the generation of renewable energy by harvesting wind with wind turbines and sun with solar installations. In brief, Reußenköge represents a recent show-case example for examining the social processes underlying the implementation of RETs in coastal areas. In the course of our qualitative study, analytical emphasis was put on people’s place attachment, their understanding of climate change and the latter two relate to the adoption of renewable energy technologies on an individual and community level. Questions addressed are the following: How does individual and collective attachment to the place of Reußenköge interact with the adoption and implementation of RETs? How do people understand and relate to the phenomenon of climate change? Has local entrepreneurship in Reußenköge shaped the municipality and in what ways? What are the important characteristics of this local entrepreneurship? In sum, the paper firstly aims at unravelling people’s place-attachment in times of RETs in the coastal municipality of Reußenköge (Devine-Wright, 2013) by analysing the social meanings associated with RETs and, secondly studies socially embedded drivers of change and perceived social adjustments connected to the transition from harvesting fields to harvesting the energy.


P-2243-14 Climate variability and change in fisher communities of Benin coastal zone: Vulnerability and adaptation strategies

F. Thoto (1); D. Houessou (1); A. Aoudji (2); S. Weissenberger (3)

(1) Centre d’Actions pour l’Environnement et le Développement Durable (ACED), Cotonou, Benin; (2) Université d’Abomey-Calavi (UAC), Faculté des sciences agronomiques (fsa), Abomey–Calavi, Benin; (3) Université du Québec à Montréal (UQAM), Institut des sciences de l’environnement (ise), Montréal, Canada

Climate variability and change are major challenges for communities in coastal regions. The coastal area of Benin in sub-Saharan Africa is also experiencing the negative impacts of climate change in form of sea-level rise causing coastal erosion and significant variations in rainfall and temperature. Fishing remains the main livelihoods mean in these coastal areas, and is directly affected by the negative effects of climate variability and change. Fishing communities of Grand Popo and Ouidah in South–western Benin are the most affected by these effects and are more vulnerable. This study used an integrated approach that combines both biophysical and socio-economic factors, determining vulnerability within a community or household. Indicators were used to develop an index of vulnerability to climate variability and change in order to compare and explain the levels of vulnerability of different communities. This research is part of a regional project funded by the Canadian International Development Research Centre which is implemented in Benin, Senegal and Canada. The findings indicate that the vulnerability of the coastal municipality of Grand–Popo is more vulnerable to climate variability and change than Ouidah in terms of the level of exposure, sensitivity, and adaptive capacity. A community with low adaptive capacity does not directly reflect a high vulnerability. It is the combination of exposure, sensitivity and adaptive capacity that determines vulnerability. However, fishing households experiencing high exposure, therefore experience more climate shocks, have a high probability of being the most vulnerable, this is the case for the municipality of Grand–Popo. Similarly, households with high exposure, high sensitivity and low adaptive capacity have a greater vulnerability. On a practical view, the findings of this research showed the importance of supporting fishing communities in diversifying their livelihoods in order to reduce their vulnerability to climate variability and change.

P-2243-15 Coastal Mitigation and Adaptation in a Small Island Developing State: Vanuatu a Case Study

SM. Von Schwerin (1)

(1) Experienced consultant, Specialising South Pacific SIDS; EBA and Eco–DRR, Dee Why, NSW, Australia

Considered one of the poorest and least developed of the Small Island Developing States (SIDS) in the South Pacific, Vanuatu is limited in its ability to respond to risks associated with climate change. An archipelago comprising 83 islands located in the western region of the South Pacific between New Caledonia and Fiji, the Climate Risk and Adaptation Country Profile (CRACP Vanuatu 2011) describes Vanuatu as being «hampered by its highly vulnerable socio–economic and ecological standing». The key challenges that limits Vanuatu’s ability to respond to climate variability and change include: political instability and weak governance; institutional capacity; a lack of economic benefits gained from existing policies; disparity in income distribution and access to basic services; and, increased urban migration to urban centers with limited employment opportunities (CRACP).

As a natural resource/environmental planning expert with over 30 years experience, living and working in Vanuatu, I present pragmatic solutions based upon my in-depth knowledge and understanding of mitigation and adaption to climate change related issues facing the Ni Vanuatu islanders. This paper will also bring to the Conference the voices and concerns of local Ni Vanuatu and Kiribati from Vanuatu regarding their current socio–economic vulnerabilities and concerns, economic drivers in conjunction with current, cultural
Adapting to impacts of coral reef bleaching on ecosystem services in Asia-Pacific

T. Yeemin (1) ; S. W. (1) ; K. W. (1) ; S. K. (1) ; S. W. (1) ; S. M. (1)
(1) Ramkhamhaeng University, Department of Biology, Faculty of Science, Huamark, Bangkok, Thailand

Ecosystem services are the benefits that humans gain from functioning ecosystems. Coral reef ecosystems provide a lot of economic benefits, especially reef tourism, recreational fisheries, fisheries production, shoreline protection and natural products. However, coral reef ecosystem services are threatened by various anthropogenic and natural disturbances. Determining how ecosystem services are associated with biodiversity is required for investigating the consequences of biodiversity loss and for setting objectives and priorities for coral conservation and management. Studies on functional redundancy within coral communities, the number of taxonomically distinct species that show similar ecological functions, are very important for understanding the consequences of biodiversity loss. A case study in the Gulf of Thailand revealed that the low Acropora coverage at the study sites before the 2010 coral bleaching event was still a result of multi-impact adaptation promoting socio-economic and ecological resilience. The case study Lapita project, which has been running almost 15 years, provides innovative adaptation and mitigation solutions for climate change from the bottom up perspective. These solutions may be readily adopted at the regional basis throughout Vanuatu and the South Pacific.

Perspectives of planners on adaptation to climate change in Indonesia

R. Josephy-Paulus (1)
(1) Local government of Buton Regency, Regional Development Planning Agency (Bappeda), Baubau, Indonesia

This paper focuses on understanding what knowledge local planners at city, regional, and provincial levels have regarding climate change adaptation (CCA), and what informs their perceptions and understanding. Four main themes were investigated: their perception of climate change impacts on local communities; the level of CCA policy development; the extent of CCA mainstreaming in the development agendas of local governments; and the level of planning for CCA. The findings were derived from the perspectives and insights of 26 local planners, working for local governments from seven different Indonesian coastal cities. Several significant factors that need to be addressed in order to plan for and implement effective CCA and disaster management at local levels in Indonesia were identified. These included increased climate change awareness at local levels; the level of coordinated efforts of government and non-governmental organisations required to enable CCA; increased capacity development to enhance community resilience; access to financial incentives and programmes; and greater motivation to address climate change impacts to enable CCA development.
2244 - Climate Change Biodiversity and Human Well-Being: illustration from forests and agro-forests systems

ORAL PRESENTATIONS

O-2244-01
Exploring causes, risks, and consequences for ecosystem services of tipping points in Latin American forests - the role of biodiversity

J. Verboom (1); B. Krujt (2); M. Perez Sobia (3); H. Baveco (3); M. Van Eupen (1); C. Von Randow (4); T. Parr (5); K. Thonicke (6); L. Jones (7); A. Boit (6); P. Balvanera (8); E. Leyequien Abarca (9); C. Huntingtonford (10); E. Blyth (11); J. Cisowska, (11); L. Martorano (12); M. Toledo (13); B. Purse, (11); D. Masante (11); M. Pena Claros (14)

(1) WAGENINGEN UNIVERSITY AND RESEARCH CENTRE, Alterra, WAGENINGEN, Netherlands; (2) Alterra, Wageningen, Ur, Wageningen, Netherlands; (3) Wageningen University and Research Centre, Wageningen, Netherlands; (4) Instituto Nacional de Pesquisas Espaciais, Ccst, Sao Jose dos Campos, SP, Brazil; (5) NERC Centre for Ecology & Hydrology, Monitoring & observation systems, Lancaster, United Kingdom; (6) Potsdam Institute for Climate Impact Research (PIK), Earth system analysis, Potsdam, Germany; (7) NERC Centre for Ecology & Hydrology, Environment centre wales, Bangor, United Kingdom; (8) Universidad Nacional Autonoma de Mexico, Centro de Ciencias del Tiempo y Espacio, Mexico city, Mexico; (9) Instituto de Investigaciones en Geologia, University of wuerzburg, Wuerzburg, Germany; (10) University of bangor, UK; (11) Wageningen University and Research Centre, Wageningen, Netherlands; (12) Universidad nacional autonoma de Mexico, Centro de investigaciones en ecosistemas, Yucatan, Mérida, Mexico; (13) Centro de Investigación Científica de Yucatán, Mérida, Mexico; (10) CEH, Wallingford, United Kingdom; (1) NERC Centre for Ecology and Hydrology, Wallingford, United Kingdom; (12) s/nº, agrometeorology, Belem, Brazil; (13) Instituto Boliviano de Investigación Forestal, Santa Cruz de la Sierra, Bolivia; (14) WAGENINGEN UNIVERSITY AND RESEARCH CENTRE, Forest ecology and forest management group, WAGENINGEN, Netherlands

This paper presents some key findings from the EU-FP7 funded projects AMAZALERT and ROBIN (Role of Biodiversity in the Climate Change Mitigation), both focusing on the effects of future climate change and land use change on ecosystem services provided by tropical forests in Latin America. New research has demonstrated that a complete dieback of the Amazon rainforest within the 21st century caused by climate change alone is unlikely; however a risk of forest dieback or other forms of irreversible ecosystem degradation on a lower spatial scale still exists. Because of the potentially severe consequences of such ecosystem degradation for the many important services they provide, on various spatial and temporal scales, it is wise to be prepared for the unexpected. Joining the outcome of the two projects, we will present a map of risk of ecosystem degradation, the main factors involved and most useful monitoring and warning mechanisms. We will evaluate the role of biodiversity in degradation as well as its potential to provide critical indicators of ecosystem decline.

Our models show forecasted changes in the biophysical state and the ecosystem services that the environment provides, under future scenarios. These allow us to compare severity of climate change, the influence of socio-economic context, and the implementation of different levels of policy protection. Ecosystem services and ecosystem services in alternative futures. The models suggest that there may be difficult trade-offs to take into account among ecosystem services, carbon and biodiversity, under these contrasting scenarios.

In combination, climate change (warming, drying, extreme events) and land use change (deforestation, fragmentation) could have a profound effect on the ecosystem, changing carbon cycle, water cycle, nutrient cycle and biodiversity in an irreversible way: from a warm, high biomass system to a much drier low biomass low biodiversity system. As trees and precipitation are bound together in a positive feedback loop (trees cause precipitation, trees need precipitation - in a hydrological cycle with evapotranspiration) evapotranspiration over trees and fire in a negative feedback loop (intact rainforest is fireproof, dry forest and savannah are prone to fire causing more tree mortality), the system has multiple steady states and a critical transition from one state to another would be hard to reverse. If such a process would occur, an Early Warning System (EWS) that would detect the imminent change would help to minimise its impacts.

Although earlier work suggested that early warning signals might exist, such that the onset of large scale dieback could be detected and potentially halted before irreversible critical transitions could occur, current work suggests that there is uncertainty whether critical degradation would show any critical ‘tipping point’ behaviour, and whether such change would be associated with detectable early-warning signals, such as enhanced but slowing down variability in variables such as temperature, rainfall that are associated with the change. Because of this, monitoring for early detection and warning of change is essential, both on the ground and using satellite images, as monitoring is prerequisite for finding solutions and early adaptation. Due to time lags between the system reaching adverse conditions and the response of the system to these adverse conditions (ecosystem degradation) we might be able to reverse the process before it becomes irreversible.

Since much of any critical change would occur through changes in the hydrological cycle, river levels, rainfall intensity, soil moisture and future range of vegetation among the most important candidates for monitoring, along with biomass, carbon exchange and energy budgets, but monitoring needs may differ according to the specific risk of subregions. Local early warning systems might first to notice subtle change in processes in their home territories, e.g. changes in ecosystem services provision, so combining high tech knowledge like satellite imagery with low tech on the ground observations should be the most promising way forward.

Actions against ecosystem degradation include reforestation, agroforestry production systems without burning, and agricultural no-tillage system.

O-2244-02
Threat to Farmland Riparian Biodiversity in Tankwidi Agroecosystem in the Sudanian Savanna of Ghana – Implication to Managing Risks to Climate Change

EA. Boakye (1); NH. Dibi (1); VR. Barnes (2); S. Porembski (3); M. Thié (4); FN. Kouamé, (1); D. Kone, (1)

(1) NASCAL Graduate Research Centre for Climate Change and Biodiversity, Université Felix Houphouët Boigny, Abidjan, Ivory Coast; (2) Faculty of Renewable Natural Resources, Kwame nkrumah university of science & technology, Kumasi, Ghana; (3) Institute of Biosciences, University of rostock, Rostock, Germany; (4) Department for Geography and Geology, University of wuerzburg, Wuerzburg, Germany

Riparian forests (RF) are integrative part of the agroecosystem as they improve water quality and serve as habitat for fauna such as birds, insects and other organisms that are essential for crop pollination, seed dispersal and nutrient cycling. Despite their importance, RF are under the threat of deforestation from agricultural intensification in catchment areas. In order to ascertain the impact of the deforestation on the riparian area, this study used remote sensing techniques and field inventorying to assess riparian forests diversity on communal farmland (FA) and protected forest reserve area (FR) along Tankwidi rivercourse in the Sudanian savanna of Ghana. The paper also discusses the findings of the research in the light of managing risks of climate change effects on farmland riparian biodiversity in the savanna zones of Ghana.

Post-classification analysis of Landsat images revealed a reduction in forest cover from 1985 (23%) to 2013 (7%) in the river catchment. This forest loss is likely to affect ecosystem services such as water yield and changes in the microclimatic conditions of the forest remnants to exert a strong effect on biodiversity in the catchment.

Further, a ground survey of sixty randomly selected plots (500 square meters per plot) equally divided between
FA and FR along the river in a 50m buffer zone showed a reduction in the number of woody species (diameter ≥ 5cm) from FR (40) to FA (19). Anogeissus leiocarpus and Mitragyna inermis were the most abundant species in both FR and FA. Shannon–Wiener Index for woody species diversity decreased from FR (2.5±0.09) to FA (1.8±0.14). This diversity decline is an indication of the degrading quality of the farmland riparian habitat and could have negative effect on the ecosystem services expected from the entire riparian biodiversity for sustainable food production.

Within the FR in particular, there were more species (58%) in the lower diameter class (5–15cm) than the higher diameter classes (15–50cm) suggesting successful regeneration. The reverse was observed in FA where the individuals in the lower diameter class were fewer (26%) than the higher diameter classes. This indicates that the FR on farmland is not being reproductive and therefore, may not be able to sustain the ecological succession of the riparian woody vegetation for the perpetuity of their functions.

The observed reduction in woody species density from FR (12.7±1.4) to FA (7.3±0.8) is likely to increase the surface exposure of the riparian area in farmland. This will increase grassy fuel loads, decrease relative humidity, increase temperature and wind speed to heighten risks to both people and livestock. Managing this risk on farmlands might be possible unless a conscious effort is made to educate farmers on the roles of riparian forests, replant to enhance the diversity and density or area excluded from farming for the full recovery of the riparian woody vegetation as a climate change adaptation strategy.

Impact of climate change on vulnerability to bushfires in Côte d'Ivoire
V. Kpan Noel (1)

In Côte d’Ivoire, climate variability related to changes in rainfall patterns since the droughts of the 70s contributed to the impoverishment of rural areas and environmental degradation (Djet, 2009). Faced with these climatic disturbances, it is imperative to study the causes of these changes and evaluate their impact on the socio-economic human activities. The consequence of these changes is the proliferation of bushfires with its attendant degradation of ecosystems in place. Bushfires are hazards that disproportionately affect the tropics. By their heterogeneity in form, these areas face triggered fires. Indeed, from December to March each year, the Harmattan blows over northern Côte d’Ivoire. The grasses become dry and the bush easily converts fuel in the presence of a spark. Increasingly, the practice of fires for land spares no region. Bushfires are hazards that disproportionately affect the tropics. By their heterogeneity in form, these areas face triggered fires. Indeed, from December to March each year, the Harmattan blows over northern Côte d’Ivoire. The grasses become dry and the bush easily converts fuel in the presence of a spark. Increasingly, the practice of fires for land spares no region.

In Côte d’Ivoire, the lights are mostly man–caused mostly for hunting (fire), grass and agric. Little firing activities during periods of soil preparation. The wildfire is an uncontrolled fire caused by the fires to burn weeds and other vegetation covering the land, pasture renewal fires for fodder for livestock, temperature air and the use of cigarettes. Lighting, camping, caravans or deliberately caused fires by bandits and cattle rustlers (Declere, 1999). The bushfires have for this purpose more disadvantages than advantages (SODEM, 2006). The proliferation of bushfires with its attendant degradation of ecosystems in place has exacerbated the drought of 70 years. Indeed, climate change has disrupted production systems including agro-forestry systems. Consequently with water deficit, the production of wood energy remains uncertain in long term to meet future needs.

This contribution tries to demonstrate the relationship between water deficit resulting from climate change and the availability of wood fuel in Casamance. It attempts to answer the question, how the reduction of rainfall over a long period affects energy production systems?

Rakhal (Yew) benefiting the knowledge of Biodiversity in Neeldhar (Pangi Valley) in the context of Climate Change for Sustainable Development
P. Sharma (1); PL. Uniyal, (1)

This paper constitutes a first attempt representing the relationship between Climate Change, Biodiversity, and Ecosystem services, with a specific emphasis on Rakhal (Yew), Neeldhar forest, Pangi valley, Chamba district, Himchal Pradesh. Firstly, we took Rakhal (Yew, Endangered plant) as biodiversity indicator that integrates changes in biodiversity with determining the level of risk for each locality. This figure shows the significant contribution in biodiversity due to some of its interesting novel populations in Neeldhar. Secondly, this indicator’s novel populations are integrated into two simultaneous situations to capture the marginal impacts of changes in biodiversity (i.e. Yew population decline) in Pangi Valley and on the value of ecosystem goods and services (Taxol) due to Climate Change. Our results confirm these novel populations play a role of Biodiversity as a nature-based policy solution for Climate Change mitigation, involving local community in Neeldhar for human livelihoods and Sustainable Development. We conclude, nature-based mitigation policies are more cost-effective and better at coping with the ethic and inequality issues associated with distributional impacts of the policy actions.

Fostering forest system resilience through managing biodiversity : the case of Mediterranean forests
F. Lefevre (1); R. Allia, (2); L. Coll, (3); H. Daly-Hassen, (4); E. Pettenella, (5)

From the socio-economic data (the map of localities, population density and the general census of population and housing (RGPH) of the Côte d’Ivoire in 1998), climate (rainfall, temperature air and the use of cigarettes) for 14 synoptic stations of the meteorological network of Côte d’Ivoire and vegetation data (NDVI and map of the dominant vegetation of the country), lights vulnerability indices have been calculated from bush. According to the results in synthetic form from the GIS map, periods favorable to bush fires and exposed areas are identified with determining the level of risk for each locality.

Pluviometric deficit and impact on wood-energy in climate changes context in the south of Senegal
SD. Badiane (1); C. A. (2); N. P. (1); K. A. (1); A. Ndiaye (1); CBCD. M. (1)

In Senegal, as in most sahelian countries, wood is still used as a primary energy source. The majority of rural households do not have access to new energies. Wood ensures for the case of Senegal, about 20% of national energy coverage. This figure shows the significant contribution in biodiversity due to some of its interesting novel populations of the country. Much of the wood energy is provided by forest in southe of Senegal. Best climate conditions in the past, contributed to maintain forest because of the presence of water. The development of the forest is dependent on the occurrence of water in the forest basin of Casamance.

The importance of forest explains the production of wood energy (firewood). The abuse of forest resources causes degradation of forest and whose low rainfall has exacerbated the drought of 70 years. Indeed, climate change has disrupted production systems including agro-forestry systems. Consequently with water deficit, the production of wood energy remains uncertain in long term to meet future needs.

This contribution tries to demonstrate the relationship between water deficit resulting from climate change and the availability of fuel wood in Casamance. It attempts to answer the question, how the reduction of rainfall over a long period affects energy production systems?

ABSTRACT BOOK 7-10 JULY 2015, PARIS, FRANCE
Mediterranean climate regions are considered as a hotspot for biodiversity, with many endemic species adapted to their hot dry summers and mild winter conditions. There, human societies have for centuries adapted their socio-economic systems to constrained climatic conditions and resource-rich landscapes, where that now, under climate change scenarios, are expected to expand rapidly at a larger scale. Thus, Mediterranean climate regions are a reservoir of resources and experience of potential interest for adaptation to climate change in other areas.

Mediterranean forests provide multiple goods and services for multiple users, including water cycle regulation and carbon sequestration at national and global level, fuelwood, forage and other products that contribute significantly to the income of the local human population. However, climate change is expected to be particularly severe at the Mediterranean margin of temperate forests. Furthermore, climate fluctuations have a higher impact in those fragile areas: tipping points can be crossed with low fluctuation. Therefore, advancing on the understanding of the resilience mechanisms of Mediterranean forest social-ecological systems is a general concern but also a potential relevant source of information.

Mediterranean forests resilience results from the interplay between human decisions and actions and natural processes. Considering the context of change, facing increased intertanglements and uncertainties, a new paradigm emerges where adaptation and long term preservation of options are both needed, following a more flexible approach to managing forests. Biodiversity is not only a reservoir of living forms with different hierarchical levels (individuals, populations, communities) but also a set of processes that permanently puts the diversity in evolution. Thus, nature-based solutions should combine exploration, exploitation and dynamic conservation of diversity and processes.

Aiming to propose solutions to foster resilience of Mediterranean forest systems through managing biodiversity, the research project INFORMED (INtegrated Resilience and Management in the Mediterranean) funded by the ERA-Net FORRENT, is conducing a broad multi-disciplinary consortium of 21 research groups from 10 countries, representing both the Northern and Southern Rim. Mediterranean forests are viewed as complex social-ecological systems where management, ecological and socio-economic processes operate at different spatial-temporal scales and interact, determining their response to disturbance and disturbance regime scenarios.

INFORMED relies on a process-based approach that integrates knowledge (i.e. data and models) issued from a broad range of case studies representing various forest types, socio-economic and anthropic change scenarios found in the area, from Northern Africa to the Mediterranean margins of temperate forests. The project aims to (1) develop a global change scenarios specifically dedicated to the Mediterranean forests, (2) develop quantitative assessment of biodiversity and functional response of Mediterranean forests to disturbance and management, (3) develop integrated assessment of ecosystem services and their dynamics based on ecosystem functions and their economic evaluation, and (4) evaluate adaptive management strategies, policy and governance options for their expected impact on resilience of Mediterranean forests.

To illustrate this original multidisciplinary research, we present the overall interdisciplinary conceptual framework where different mechanisms of flexibility are considered jointly, and the first evidence deriving from the past work on resilience in the selected case study areas.

Current status and potential impacts of climate change on the distribution of consumed plants species by the endangered western derby eland (Taurotragus derbianus derbianus) in its last wild refuge Niokolo Koba National Park, South-Eastern Senegal

M. Camara (1) ; S. Da Sié (2) ; FN. Kouame (1) ; S. Bienvenu (3)

(1) GRP Climate Change and Biodiversity, University félix houpouhô-Boïny, Abidjan, Ivory Coast; (2) Competence Center of the West African Science Service Center Climate Change and Adapted Land Use, Biodiversity modelling, Ouagadougou, Burkina Faso; (3) Institut des Sciences de l'Environnement, (ise/ifst) university cheikh anta diop of dakar, Dakar, Senegal

Within the last decades, biodiversity became an important topic of social, political and scientific discussion because of its essential role in human well-being and survival. However, biodiversity is facing increasing threats, leading to its loss, caused by different factors among which climate change. It is urgent to take action to ensure its sustainable use and conservation. The Western Derby Eland (Taurotragus derbianus derbianus Grav. 1847), the biggest antelope worldwide is recorded as endangered species even close to extinction. Endemic to West Africa its wild habitat is shrunk nowadays to Niokolo Koba National Park (NKNP) Southeast Senegal with Soudano-Guinean climate, where an exponential decrease of its population is noticed. Conservationists in hope of preserving its genetic pools established the first breeding herd worldwide to an ex-situ conservation site, the Bandia reserve Centre West with a Sahelo-Soudanian climate. Researches have been carried out on derby eland in wild but they had a narrow-scope, mainly oriented on aerial and ground survey in the national park. Unfortunately, very limited is known about the wild eland in its last natural refuge. Previous studies have defined Boscia angustifolia, Grewia bicolor, Hymenocarodia acida, Strychnos spinosa and Ziziphus mauritiana as consumed woody species by eland. A step to maintain and allow the population increase of Eland within the NKNP is to assess the presence of these woody species in the area. Therefore, knowledge on their current and future distribution within the NKNP is important to assess the susceptibility of the eland in its last wild refuge. The aims of this present work are to (i) identify the current potential distribution of eland’s consumed plant species with climatic and land-cover variables, and (ii) predict the future potential distribution of these species based on different climate models and scenarios for decision makers and rangeland managers. To achieve these aims two types of dataset are necessary: species occurrences and climate variables. Species’ occurrence points of each woody species were obtained from field observations and additional records from herbaria of natural collection downloaded from GBIF website (Global Biodiversity Information Facility). Environmental variables were downloaded from Worldclim database for climate data and from the Global Landcover database for land cover variables. Possible impacts of climate change on the consumption are presented. The consumed plant species in the Park were analyzed based on three climate models (CNRM-CM5, HadGEM2-ES, and MPI-ESM-LR) and two climate scenarios (RCPs 2.6 and 8.5), at two methods of time (daily and seasonal) and two methods of potential distributions of suitable habitats for the woody species were determined at a spatial resolution of 30 arc-second using the Maximum Entropy (MaxEnt) approach.

Preliminary results of the ongoing analysis show a good potential distribution of consumed plant species by eland in the NKNP in general. Three out (Grewia bicolor, Hymenocarodia acida, and Ziziphus mauritiana) of the five woody species are found almost everywhere within the park. In contrary, Strychnos spinosa has is range restricted to the central part while Boscia angustifolia is confined in the eastern part. Projections illustrate a negative impact of climate change on the consumed plants by the eland, with a severe loss of suitable habitats for most of the species, except from Hymenocarodia acida and Ziziphus mauritiana, which will likely remain within the NKNP.

The loss of suitable habitats for the consumed species by eland will have negative impacts on his maintenance in the park. We therefore recommend the development of strategies for a good conservation of these remaining plant species by reducing for example human actions.

Climate change adaptation for the Amazon basin: how can ecosystem-based solutions be multiplied?

P. Ceotto (1) ; T. Kasecker, (2) ; R. Pinheiro, (1) ; JMC. Da Silva (3) ; FR. Scaraní (4)

(1) Conservation International, Americas Sustainability
Climate change impact of loss Agro-biodiversity in Georgia

K. Nadiradze (1) ; M. Goginashvil (2)
(1) Association for Farmers Rights Defense, AFRD, President, Tbilisi , Georgia; (2) Tbilisi State University, Economic and business faculty, Tbilisi, Georgia

Climate change is occurring more rapidly than anticipated and the increase in extreme weather events threatens more destructive changes in agriculture. Using new technologies, current institutional structures seem inadequate to achieve the mitigation needed to adequately slow climate change effects, while also meeting needed food security, climate, and biodiversity objectives. In developing countries, especially those in Europe, such as Georgia, the need for efficient action to secure the resilience of ecosystems is evident. The potential for loss or destruction of biodiversity is a key geography to implement and learn from practices to enhance the capacity of buffer to support human communities against the adverse impacts of climate change. The Amazon region simultaneously holds the largest continuous green tropical cover of the planet and a population of more than 10 million Indigenous people, many of which live in poverty. The poorest are the most vulnerable people to climate change. Then, these characteristics turn the Amazon into a key geography to implement and learn from practices related to ecosystem-based adaptation and sustainable development. Protected area networks, indigenous territories, community management, investment incentives and forest restoration are all practices that could help the region to cope with as long as they reduce vulnerability to climate change by protecting natural resources and improving livelihoods.

In this paper we review some of the existing national and sub-national policies and practices taking place in the Amazon that can be classified as Eba. Mapped cases include from national-level policies (such as those related to low carbon development agreements), to local level initiatives (such as sustainability policies at municipal level or community management of areas under protection). We analyzed the selected cases on the basis of the following criteria: resilience potential, risk reduction, cost-effectiveness, emissions reduction, replicability, and scalability. We emphasize the need to showcase, measure and share successful stories in order to disseminate solutions across the region. Main conclusions are that 1) protected areas networks and indigenous lands that add up to more than 45% of the total cover the Amazon need further consolidation; 2) national and sub-national policies and incentives need further assessment but have a high potential for replication across the region; 3) efforts aiming for sustainability at sub-national level must be measured and understood for potential replication or to inspire the design of new policies; 4) adaptation to climate change in Amazonia will be predominantly ecosystem-based, but planning requires regional level integration and exchange of policies and practices between national and sub-national actors.
a vision to guide our transition toward sustainability, on scales ranging from local landscapes to the planet as a whole. Sustainability science is at the core of this vision, and landscapes and regions represent a pivotal scale domain. The main objectives of this paper are: (1) to elucidate key definitions and concepts of sustainability, including the Brundtland definition, the triple bottom line, weak and strong sustainability, resilience, human well-being, and ecosystem services; (2) to examine key definitions and concepts of landscape sustainability, including those derived from general concepts and those developed for specific landscapes; and (3) to propose a framework for developing a science of landscape sustainability. Landscape sustainability is defined as the capacity of a landscape to consistently provide long-term, landscape-specific ecosystem services essential for maintaining and improving human well-being. Fundamentally, well-being is a journey, not a destination. Landscape sustainability science is a place-based, use-inspired science of understanding and improving the dynamic relationship between ecosystem services and human well-being in changing landscapes under uncertainties arising from internal feedbacks and external disturbances. While landscape sustainability science emphasizes place-based research on landscape and regional scales, significant between landscape interactions and hierarchical linkages to both finer and broader scales (and externalities) must not be ignored. To advance landscape sustainability science, spatially explicit methods are essential, especially environmental economics to the advantage of spatially explicit landscapes and multi-scaled simulation models that couple the dynamics of landscape services (ecosystem services provided by multiple landscape elements in combination as emergent properties) and human well-being.

**Keywords:** Sustainability _ Landscape sustainability science _ Ecosystem services _ Human well-being _ Key research questions and approaches

**P-2244-06**

**Building Resilience at Sub National level Using Climate Resilience Framework**

SK. Yadav (1) ; A. Dixit, (1)
(1) Institute for Social and Environment Transition–Nepal (ISET–N), Research, Kathmandu, Nepal

Nepal’s ecosystems generate various goods and services for people. With climate change, direct consequences on the hydrological cycle can impact ecosystems, lives and livelihoods seriously and adversely. These changes will lower the resilience of ecological and infrastructural systems as well as the functioning of water, food and livelihoods services. Ecosystem based adaptation as an element of an overall strategy can help reduce the vulnerability of ecosystems and build people’s resilience in the face of the adverse impacts of climate change. This paper will present the use of climate change vulnerability in wake of changing climate taking into account the role of ecosystem services using the climate Resilience Framework (CRF). The CRF conceives climate vulnerability to be highest when increased exposure intersects with fragile systems, social marginalization and constraining institutions. Drawing on findings of research conducted in Nepal’s Western Development Region, the paper will discuss the use of both top down and bottom up approach to assess risks and develop strategies for building resilience at sub national levels.

**2245 - Modelling the complexities of the Earth System**

**ORAL PRESENTATIONS**

**K-2245-01**

**Why do we use Earth System models ?**

J.-L. Dufresne (1)
(1) Laboratoire de Météorologie Dynamique – IPSL, UPMC/ CNRS, Paris, France

Not communicated.

**O-2245-01**

**Mitigation delay sensitivity of temperature, sea level and ocean acidification**

P. Pfister (1) ; T. Stocker (1)
(1) Physics Institute, University of Bern, Climate and environmental physics, Bern, Switzerland

With annually increasing anthropogenic carbon emissions, the commitment to climate change and its impacts continues to grow. A policy–relevant metric for this growth is the mitigation delay sensitivity (MDS), measuring the additional commitment per decade until emissions start to decrease. For the peak temperature increase ΔT, MDS can be estimated analytically using idealized emission scenarios (Allen and Stocker, 2014; Stocker, 2013). Here, we use an Earth System Model of Intermediate Complexity to evaluate the MDS of ΔT, steric sea level rise (SSLR), and two ocean acidification impacts following Steinacher et al. (2013). We examine the dependence of the MDS on the rate of increase (r) and subsequent decrease (s) in anthropogenic emissions, for emissions for three different equilibrium climate sensitivities (ECS) of 1.5, 3.0 and 4.5 K. The modeled MDS is in good agreement with analytical estimates for ΔT and SSLR, except for scenarios with very high cumulative emissions (for standard parameters ECS = 3.0 K, r = 2% and s ranging from 5% down to 0.5%), MDS amounts to 0.3–0.7 K/decade for ΔT and 7–20 cm/decade for SSLR by 3000 AD. With regard to ocean acidification, we find that partial Aragonite undersaturation of the Southern Ocean surface (by 2100 AD) may be avoided with 30% down to 0.5%), MDs amounts to 0.3–0.7 K/decade for ΔT and 7–20 cm/decade for SSLR and s ranging from 5% down to 0.5%), MDs amounts to

**Keywords:** Climate _ Ocean warming _ Climate change _ Mitigation delay sensitivity _ Sea level rise _ Ocean acidification

**P-2244-02**

**Do ENSO modeling discrepancies affect the climate-carbon feedback?**

A. Bastos (1) ; C. Gouveia (1) ; R. Trigo (1)
(1) Instituto Dom Luiz – Universidade de Lisboa, Lisbon, Portugal

The El-Niño/Southern Oscillation controls most of global climate variability on inter-annual time-scales. In particular, ENSO affects temperature and precipitation patterns in South America and Southeast Asia, although its influence extends to remote regions and latitudes. ENSO is also known to play an important role in the carbon–cycle, influencing a large fraction of variability in atmospheric CO2 growth rate, mainly due to its impact on terrestrial ecosystems in the Southern Hemisphere. During El-Niño events, lower than average precipitation and warmer temperatures are registered in most of northern and central South America, South Africa and most of Australia, leading to reduced CO2 uptake by vegetation, and to increased fire activity. During the cold phases (La-Niña), the patterns are approximately reversed and the land–sink is enhanced.

Although Earth–System Models (ESMs) in CMIP5 do include representation of the ocean–atmosphere coupling processes that produce ENSO, they still present difficulties in modeling some of the most relevant features of the phenomenon, such as the temporal evolution and recurrence periods of warm and cold phases.

It has been shown that the difference between model estimates of future CO2 concentration are related to their biases in representing present atmospheric CO2. Moreover, the larger disagreements of future CO2 uptake are due to...
uncertainty about the future response of the land–sink to climate change. It has been further suggested that the uncertainties in future estimates of CO2 storage on terrestrial ecosystems are related to the differences in the climate forcing from the global circulation models (GCMs).

Here we investigate whether the discrepancies between observations and modeled ENSO may explain biases in the modeled present land–sink in CMIP5 ESMs. We evaluate the performance of ESMs in reproducing, for the period 1959–2011, a set of temporal features, such as the intensity, spatial configuration, and spectral properties of ENSO. Subsequently, the ability of ESMs to reproduce the global land–sink strength and variability was evaluated and compared to the relationship between the modeled ENSO and variability in the modeled land–sink. We find that biases in the land–sink are related to the way ESMs simulate the terrestrial CO2 uptake, the terrestrial CO2 uptake variability and that this, in turn, is mainly dependent on the spectral properties of the modeled ENSO. The ESMs that miss-represent the peak periodicity of ENSO in the 3-yr. and 7-yr. bands and the modeled land–sink characteristics. The nature of this relationship between ENSO discrepancies and land–sink biases was studied by evaluating the influence of discrepancies in ENSO frequency on temperature and precipitation patterns within each model.

The analysis was further extended to the future RCP4.5 and RCP8.5 scenarios, by evaluating the influence of the discrepancies of the present terrestrial CO2 uptake on the future land–sink and the role played by ENSO in these discrepancies.

O-2245-03

**Spread of ocean heat uptake efficiency in CMIP models**

E. Exarchou (1); J. Gregory (2); T. Kuhlbrodt (2)

(1) IC3, Barcelona, Spain; (2) NCAS, University of Reading and Met Office Hadley Centre, Reading, United Kingdom

During transient climate change, the ocean heat uptake efficiency, quantified by the ratio between the rate of ocean heat uptake N and surface global-mean temperature change DT, can quantitatively measure how effectively the heat is vertically transported in the deeper ocean, thus moderating surface transient change. Among models of the Coupled Model Intercomparison Project (CMIP) framework, the spread in the values of k varies by about a factor of 2. The spread in k affects the model’s spread of projections of ocean heat uptake and thermal expansion, therefore contributing to the uncertainty in model future projections of transient climate change. We investigate potential factors that may explain the spread of k among CMIP models with CO2 increasing at a rate of 1% per year. In the set of models we analyse, in line with previous studies, models with the strongest AMOC have the strongest CO2-induced AMOC reduction. We find that the models with the strongest AMOC, and consequently the models with the strongest AMOC reduction, have the strongest k. This model efficiency. Despite the strong correlation with AMOC, the largest portion of the ocean heat uptake efficiency and of its spread comes from the Southern Ocean. By further analysing the detailed process—based heat budgets in three models, HadGEM2, GFDL–ESM2M and MPIESM–LR, which have k values from the low, middle and high part of the kappa spread, we find that the spread in these three models mainly arises from changes in the meridional component of the ocean heat transport, with the heat uptake takes place in the Southern Ocean. We explore potential physical mechanisms that link the Southern Ocean advective heat uptake, hence the Southern Ocean overturning, with the AMOC and the ocean heat uptake efficiency.

O-2245-04

**Forest Mortality, Economics, and Climate**

L. Hawkins (1); B. Law (2); P. Mote (3); A. Plantinga (4); J. Hicke (5); M. Allen (6); R. Betts (7)

(1) Oregon State University, Earth, Ocean, and Atmospheric Science, Oregon, United States of America; (2) Oregon State University, Forest ecosystems & society, Oregon, United States of America; (3) Oregon State University, Earth, ocean, & atmospheric sciences, Oregon, United States of America; (4) University of California Santa Barbara, Natural resource economics and policy, California, United States of America; (5) University of Idaho, Geography, Idaho, United States of America; (6) University of Oxford, School of geography and the environment, Oxford, United Kingdom; (7) University of Exeter, Geography, Exeter, United Kingdom

Forests in western North America provide critical economic and environmental services including watershed protection, timber production, and carbon sequestration. Recently this region has experienced widespread forest mortality attributed to drought and warming. Forest mortality rates doubled in the Pacific Northwest between 1990 and 2010 with bark beetles killing trees across 11 million hectares in B.C. and the western U.S. The complex interactions among climate, ecosystem response, and economic factors govern the impacts these stressors will have on terrestrial ecosystems in the future. To examine how major forests will function under future climatic and land use regimes we developed an improved forest mortality model to NCAR’s Community Land Model (CLM4.5) incorporating a predictive model of mountain pine beetle outbreaks and a forest product economic model. The economic model estimates the values of private forest investment, wood products, recreation, and water. Annual harvest levels, silvicultural investments, and forest management strategies feedback into CLM. This methodology will elucidate feedbacks among climate, land use, forest ecosystems, carbon sequestration and ecosystem services. To assess uncertainty in the simulated forest response to climate change a dynamic vegetation model (TRIFFID operating within the Hadley Centre Earth System Model) is used to generate a super--ensemble of simulations using crowd sourced computing power (https://climatemodeling.net). This form of evaluating intrinsic variability allows for thorough investigation of model sensitivity to parameterization. Outcomes of this work will provide policy makers and resource managers with tools for developing adaptive strategies for responding to projected warming, drought, insects, and economic factors.

O-2245-05

**Modeling and visualization of the marshes vegetation**

A. Sadovski (1); P. Montagna, (2); S. King, (3)

(1) TexasA&M University–Corpus Christi, Corpus Christi, TX, United States of America; (2) Texas A&M University–Corpus Christi, Harte research institute for the gulf of mexico, Corpus Christi, United States of America; (3) Texas A&M University–Corpus Christi, School of engineering and computing sciences, Corpus Christi, United States of America

This paper deals with a mathematical models of the vegetation growth in the marshes of the Gulf of Mexico. It is based on a spatial–temporal system of partial differential equations. In this paper the system is presented in the form of the system of partial differential equations. Analysis of the behavior of such a system is studied through simulation and visualization tools. The objective of the study is to find the impact of fresh water releases and precipitations on the vegetation cover of marshes so it can be used for future preservation of the marsh ecological system.

Coastal marshes are important ecosystems that provide many benefits to human health and well-being including: protecting the inland areas from storm surge, storing water, removing nutrients that flow in from watersheds, and providing nursery habitat for key commercial and recreational fisheries. Yet, marshes are under extreme pressure from development and 50% of the marshes nationwide have disappeared since the founding of the United States.

The Texas coast is flat, hot, and windy; which makes coastal marshes very susceptible to effects of climate change and water resource development. Climate change can have three effects: sea-level rise, water cycle alterations, and temperature alterations. The main effect on marshes during rising water levels or dry them out as evapotranspiration rates increase during droughts. Water resource development has decreased water delivery to marshes in the Nueces Delta by 55% over the last 40 years, which has led to marsh degradation.

There is a need to understand the dynamics and the interactive roles of climate and water cycle changes in order to predict changes in salt marshes in the future. This information is critical for resource management. However, few tools exist to forecast effects of human activities on marsh function. Results and models of this
The role of uncertainty in the field of climate change has been widely discussed in recent years. A focus has been on the role of uncertainty in the climate sciences part of climate change, in particular uncertainty about the magnitude of climate change due to greenhouse gas emissions, e.g., as measured by the famous climate sensitivity parameter. In applied policy analysis, integrated assessment models (IAMs) can be used to assess the costs and benefits of climate change policies. Besides the crucial climate parameters and impact estimates, these models require the specification of a baseline population and GDP growth scenario along which optimal climate policies are studied.

We focus on the role of socio-economic uncertainty to address three research questions that come up in this context. Firstly, we ask what is the optimal climate policy and how robust is it in the presence of socio-economic uncertainty taking into account the costs of the uncertainty and how different decision rules for finding the optimal climate policy when the baseline is unknown can be derived including making use of recent developments in the context of robust decision making. Secondly, and related, we discuss how measures of the costs of climate change and climate policies can be measured and compared when different baselines are considered. Given that policy costs and other measures such as impacts are typically expressed relative to a baseline, comparing those values with different baseline projections is not trivial as we show. Thirdly, we more broadly discuss how scenario development exercises can inform decisions under uncertainty. notably, we estimate the cost of this uncertainty taking into account the different “worlds” described.

Regional Arabian Peninsula Modeling Findings and Integrated Climate Change Programme

J. Jane (1)

(1) Abu Dhabi Global Environmental Data Initiative (AGEDI), Abu Dhabi, United Arab Emirates

ACEDI launched a follow-up to this initial study of Climate Change in the UAE in 2011 with the aim of establishing a climate change work programme that could build upon, expand and deepen the understanding of vulnerability to the impacts of climate change as well as identify practical adaptive responses at the local, national and regional levels. A 5-stage stakeholder consultative involving nearly 100 stakeholders helped define the overall scope of the programme, and establish the types of outputs considered to be the most useful for future policymaking at the multiple scales envisioned.

The first-of-its-kind effort in the Arabian Gulf, the project represents a timely and critical response to regional leaders, innovators and decision-makers better understand critical stakes and the range of options available to them across the key thematic areas. The 12 integrated sub-projects also represent an organizing framework to engage partners from across the region on issues that are widely considered to be high priority, while also involving several international organizations to facilitate replication in other regions of the world.

The first two subprojects on high resolution modeling for both atmosphere and the Arabian Gulf are now complete and being openly shared. The findings create foundational information for the remaining projects of the programme. Interestingly, the results towards modeling forecasting monthly, seasonal and annual precipitation in four selected stations in North West of the Iran namely Tabriz, Ardabil, Khoy and Urumia and testing the accuracy of stepwise regression for post processing the outputs of model, in a 30-years period from 1982 to 2011. The required observed weather data of study stations running regional climate model RegCM4 were collected from Iran Meteorological Organization (IRIMO) archive and rest of the data were adopted from ICTP database, with NetCDF format including three sets of weather data (NNRP) with a 6-hour-time step and a horizontal resolution of 2.5 2.5 on the reanalysis data of National Center of Environmental Prediction of United States, sea surface temperature, (SST) with horizontal resolution of 1 degree from the type of (OISST) belonged to National Oceanic and Atmospheric Administration and surface data (SURFACE), which were consisted of three topographic data (GTOP), the vegetation or land use of (GLCC), and the soil type data (GLZB), with a horizontal resolution of 30 30 seconds from United States Geological Survey, for the period 1982 to 2011. To determine suitable rainfall scheme, the normal year of 2009 was selected for running the model using different schemes Accordingly, Kuo scheme with the minimum bias, comparing to observed precipitation amounts in the entire 36 synoptic stations of the region, was chosen as the main scheme. The time interval was set as 24-hour, spatial resolution of 30 30 km2, and the number of grid points were 152 in longitude (9°) and 168 in latitude (8°) during the study period of 1982 to 2011. Geographical place was also taken into account, namely the state of (E), respectively. The outputs of the model are three types; atmospheric (ATM), surface (SRF) and radiation data with the format of NetCDF, each containing a large amount of meteorological variables, and the precipitation (ptp) from the model outputs, the nine significant variables with the highest correlation with precipitation were determined as: q2m 12m, dps 1000 500 u1000 u500 01000 omega1000 omega500. For post-processing the outputs of the model, the multiple linear regression (MLR) approach was used. Except for the warm month, the output of RegCM4 showed a wet bias and overestimation. Applying multivariate linear regression equation, and (in some cases two-variable) on the output of the model led to a better agreement between observed and simulated values of precipitation. It is noted that the 75% of cases, the bias and relative error decreased for the monthly, seasonal and annual forecasts. At all stations except for Urumia, performing the post processing improved the accuracy of RegCM4 output at all time scales. Further scrutiny is recommended for explaining the variations among the stations.
of sea level change and what are its current limitations as opposed to scenario building have create rich dialogue which has helped bridge the disconnect between the science–policy interface.

The modeling has occurred in a nested configuration to cover the Arabian Peninsula at a 12 km grid and a 4km grid over the UAE as well as part of Oman and Saudi. 4km is extremely computationally heavy and substantially more robust than previous studies undertaken by EAD etc. The Oceans Modeling is also run at 1 km resolution which is also incredibly precise in comparison to global modeling which we also used for past studies in the region.

Regional Ocean Models (ROMs) are essential for understanding how future climate change will affect specific locations within the world’s oceans. Such models are significant improvements over coarse resolution ESMs because they more realistically capture local oceanographic processes and characteristics, such as sea surface temperature profiles, circulation patterns, fresher simulations of the Earth’s climate.

The ROM for the Arabian Gulf has been developed, based on ESM boundary conditions and local data, and used to make climate change projections out through the late 21st century. The outputs of the study provide a Gulf specific basis on which to conduct the subsequently planned vulnerability assessments of the programme regarding marine biodiversity and socioeconomic systems, as well as being an asset to researchers in the region regarding future climate change and the marine environment.

Regional atmospheric modeling is essential for understanding how climatic conditions will change at specific locations within the region. Such models are a significant improvement over global models because they more realistically represent local to regional meteorological dynamics, such as orographic precipitation, land–ocean wind breezes and circulations, surface heating and evaporation, topography and off-shore wind patterns, and other factors that influence current and future climate.

The primary goal of the regional atmospheric modeling using WRF was to develop projections of regional climate for the Arabian Peninsula at fine spatial and temporal scales. The modeling effort builds off and reflects the large-scale features noted and trends from GCM simulations based on the IPCC’s 5th Assessment Report (AR5). The modeling was conducted on the NCAR-Wyoming Supercomputer or “Yellowstone”.

The outputs of the study provide a Gulf region-specific basis on which to conduct subsequent planned vulnerability assessments under the programme regarding terrestrial biodiversity, water resources, coastal zones and socioeconomic systems.

P-2245-04

Southern Ocean wind response to North Atlantic cooling and the rise in atmospheric CO2

SY. Lee (1)  
(1) Academia Sinica, Research Center for Environmental Changes, Taipei, Taiwan

Southern Ocean, believes to be a CO2 sink (Takahashi, 2012), remains a mystery player in understanding the global carbon cycle and in predicting future climate changes. The warming in marine proxy records indicates an intensification of wind–driven upwelling in the Southern Ocean during the late Pleistocene glacial terminations and suggests that the anomalous southern hemisphere midlatitude westerlies were forced by North Atlantic cooling via atmospheric teleconnection (Anderson et al., 2009). In this study, we investigate the response of Southern Ocean climate to North Atlantic cooling using an ACCM coupled to a reduced gravity ocean to link the empirical observation with climate theory. In comparison between our cooling and basic state experiments, we observed a nearly 25% increase in the Southern Ocean wind speed in response to the altered Hadley circulation on the Southern Ocean winds. In light of the vital role of the Southern ocean ventilation to atmospheric CO2 concentration, we forced an earth system model with dynamical biogeochemical cycle by anomalous wind field observed the AGCM and found a ~20 ppm atmospheric pCO2 rise in equilibrium state. The model results support the hypothesis that the Southern Ocean wind–driven upwelling was susceptible to intensified North Atlantic cooling under glacial climate. We emphasize the intimate coupling between the northern and southern hemisphere climate via atmospheric teleconnection mediated by tropical climate system.

P-2245-05

Climatic sensitivity of the Brazilian Earth System Model integration submitted to abrupt CO2 change

JF. Pesquero (1) ; N. Paulo (1)  
(1) National Institute for Space Research, Center for Weather Forecasting and Climate Studies, Cachoeira Paulista, Brazil

This work analyzes the climatic sensitivity response of the Brazilian Earth System Model (BESM—version 2.5) when exposed to abrupt CO2 changes. We will calculate differences between two, 30 years experiments of the BESM model, from 2007 to 2036 (30 years), both of runs start from a 150 years spinup, but one run takes the atmospheric CO2 constant concentration at preindustrial values (280 ppmv) and the other has constant and abrupt 1200 ppmv (“4xCO2”). The work analyzes the differences of abruptly changed integrations (1200 ppmv) and not abruptly integrations (280 ppmv), more precisely, calculating 12 Climate Extreme Indices using the fields of precipitation, minimum and maximum temperature over South America. The difference of 4xCO2 and 280 ppm integrations for Constant Drier Days (CDD–CLIMDEX index) are showing 60 days of increased CDD over northern South American continent. Note that both of the Northeast as the southeast and southern Midwest regions of Brazil are showing similar characteristics in magnitude of CDD between 5 and 30 days. The BESM model Total Precipitation (PRCTOT–CLIMDEX index) indicates an increase from 50 to 200 mm on the South, Southeast of the Midi West of Brazil. The Constant Wet Days (CWD–CLIMDEX index) are showing decreasing 20 days over the great part of North Region of Brazil. When comparing BESM Frost Days (FD–CLIMDEX index) with FD of the Community Climate system Model (CCSM4), there is a very similar pattern but the BESM showed elevated number of FD. When comparing Summer Days (SU Climate index) between BESM and CCSM4 models, both of models showed very similar profile of Summer Days, but the CCSM showed smaller values than BESM. Finally, these results showed that the model BESM has a good climatic sensitivity response.

P-2245-06

A theoretical Basis for Integrated Assessment Models

FA. Pinto Siabatto (1)  
(1) PIK, Potsdam, Brandenburg, Germany

A mathematical model that couples structural change of countries and flows’ dynamics has been developed. It proposes a comprehensive representation of the socioeconomic structure. The model introduces an explicit declaration of three principal processes: (1) the propagation of damages from uncertain impacts in economic activities, and socioeconomic adjustments that bring about the adaptive capacity. It also holds a representation of resilience. The model addresses the socio-economic problem that needs to be solved. Working out this problem will allow the numerical assessment of resilience. It also paves the path to the harmonization of metrics relating resources, economic flows and social welfare.

P-2245-07

Photochemistry of ozone at the surface of cloud water droplets: insights from computer simulations

M. Ruiz-Lopez (1) ; J. Anglada (2) ; M. Martins-Costa (1) ; JS. Francisco (3)  
(1) University of Lorraine, SRSMC, Vandoeuvre-lès-Nancy, France; (2) CSIC, Departament de química biològica i modellització molecular, Barcelona, Spain; (3) University of Nebraska–Lincoln, College of arts & sciences, Lincoln, NE
Atmospheric reactions in condensed media such as water droplets, organic aerosols, soot, sea salt particles, etc., are thought to play significant roles in the troposphere. Reactions at surfaces have attracted special attention, in particular those occurring at the air/water interface of water droplets since clouds represent about 7% in volume of the troposphere. Typically, water droplets exhibit a high surface area to volume ratio and this is certainly a determining factor for surface reactions to compete with bulk reactions. The molecular properties of compounds interacting with an aqueous interface have been often considered as being intermediate between the properties in the two bulk phases but there is now compelling evidence that chemistry at the air/water interface may be quite different from both the gas and the bulk.

However, the experimental study of chemical processes at aqueous interfaces is not straightforward. To get further insights in this domain, in the last few years, we have developed a computational strategy that combines quantum chemistry methods, classical molecular mechanics models, and computer simulations based on the molecular dynamics approach.

In this communication, we report recently obtained results for the photochemistry of ozone at the surface of cloud water droplets. Photolysis reactions are central to atmospheric chemistry. Ozone in particular, absorbs UV and visible light and photodissociates to produce molecular and atomic oxygen either in the ground or excited states. Atomic oxygen can then react with water or methane molecules to form the highly reactive hydroxyl radicals, often referred to as the “detergent” of the troposphere. These processes have been widely investigated in the gas phase but when ozone is adsorbed at the surface of cloud water droplets, the ozone–water interactions modify the spectral signatures, and the mechanism and the kinetics of the photolytic (and subsequent) processes are presumably different and deserve to be investigated in further detail.

Indeed, our computer simulations predict that the hydroxyl radical formation rate at the air/water interface is enhanced by four orders of magnitude, suggesting that clouds can influence the overall oxidizing capacity of the troposphere on a global scale.
K-3301-01

Climate Intervention: A Summary of the U.S. National Research Council Report on Geoengineering

W. Abdalati (1)
(1) University of Colorado, CIRES, Boulder, CO, United States of America

Climatologically, humans are in unfamiliar territory. Failure over the last few decades to adopt substantive climate mitigation strategies has continued to stress the planet in ways that present some well-understood and some poorly understood risks that pose a threat to human livelihood across the globe. These risks, which continue to increase as greenhouse forcing proceeds unabated, have raised some important questions about the viability of climate intervention (often referred to as geoengineering) as a means to avoid or reduce some of the consequences of climate change. Strategies for such intervention fall into two categories, representing two very different approaches to addressing the climate challenge. The first is carbon dioxide reduction – the removal from the atmosphere and reliable storage of carbon, which has elements of a mitigation approach in that it seeks to reduce the amount of CO2 that enters or remains in the atmosphere. The second is albedo modification, which seeks to increase the amount of sunlight reflected from the Earth, thus reducing the surface incident radiation.

There is a pressing need for a careful and clear scientific foundation that can inform ethical, legal, and political discussions surrounding climate intervention. Toward that end, the National Research Council (NRC) of the U.S. National Academy of Sciences undertook a study to assess the current state of knowledge associated with climate intervention. The study resulted in a set of recommendations to inform future decisions on possible climate intervention research and deployment. This talk will present the NRC committee’s findings and recommendations, which speak to: the state of readiness of climate intervention methods and the associated challenges, their value in the context of mitigation and adaptation strategies, research needs for advancing our understanding of climate intervention approaches in order to make informed decisions on their deployment, and governance considerations for such research.

Climate intervention is fraught with a wide range of risks and uncertainty. The key question that underpins the need for and approach to research is whether climate change may push society to a state in which the risks associated with non-intervention may outweigh the risks of intervention. Making such an assessment requires a foundation of knowledge and understanding.

K-3301-02

Volcanic Eruptions as an Analog for Stratospheric Geoengineering

A. Robock (1)
(1) Rutgers University, Department of Environmental Sciences, New Brunswick, NJ, United States of America

In response to the global warming problem, there has been a recent renewed interest in geoengineering “solutions” involving solar radiation management by injecting particles into the stratosphere, brightening clouds or the surface, or blocking sunlight with satellites between the Sun and Earth. No systems to conduct geoengineering now exist, but a comparison of different proposed stratospheric injection schemes, using airplanes, balloons, and artillery, shows that using airplanes to put sulfur gases into the stratosphere would not be expensive; nevertheless, it would be very difficult to create stratospheric sulfate particles with a desirable size distribution. While volcanic eruptions have been suggested as innocuous examples of stratospheric aerosol cooling the planet, the volcanic analogy also argues against geoengineering because of ozone depletion, regional hydrologic responses, and other negative consequences. Volcanic eruptions are an imperfect analog, since solar radiation management proposals involve the production of a permanent stratospheric aerosol layer, while the volcanic eruption is episodic. Nonetheless, we can learn much from the volcanic example about the microphysics of stratospheric sulfate aerosol particles; changes in atmospheric circulation, producing regional climate responses, such as changes to the summer monsoon; atmospheric chemistry; changes of the partitioning of direct and diffuse insolation; effects on satellite remote sensing and terrestrial-based astronomy; and impacts on the carbon cycle. There are 26 reasons why geoengineering may be a bad idea, and five reasons why it might be a good idea. Some of these can be evaluated with climate modeling, and some using the volcanic analog. Observations of the next large volcanic eruption will help to understand the evolution in stratospheric sulfate aerosol size distribution over the first few months after the eruption. Much more research is needed before we can quantify each of these, so that policymakers in the future can make informed decisions about whether to ever implement stratospheric geoengineering. Given what we know today, global efforts to reduce anthropogenic emissions and to adapt to climate change are a much better way to address anthropogenic global warming.

K-3301-03

The governance of solar geoengineering

S. Schäfer (1); N. Moore, (1)
(1) Institute for Advanced Sustainability Studies, Potsdam, Germany

This talk will give an overview of past developments in the governance of solar geoengineering research, contextualize these developments within broader debates on research governance, and conclude with an outlook on how the early governance of solar geoengineering research is relevant to potential future dynamics of international conflict and cooperation on solar geoengineering. Solar geoengineering research has proven fertile ground for calls for and adoption of understandings that reflect new characterizations of science (for example, as ‘post-normal’), new ways of assessing scientific results (for example, through ‘extended peer review’ or ‘technologies of humility’), and new processes for conducting research (for example, ‘transdisciplinarity’ or ‘mode 2 science’), which aim to foster cooperation between broader sets of stakeholders and thereby to accommodate their values and beliefs into the research process. Whether these can be put into practice or not will set precedents and norms that are carried forward into negotiations over future activities, including those that may be deployment-related.

O-3301-01

Studying the limitations of stratospheric aerosol injections by microphysical processes and interaction with radiation using the IPSL climate model

C. Kleinschmitt (1); O. Boucher (2); U. Platt (1)
(1) Heidelberg University, Institute of Environmental Physics, Heidelberg, Germany; (2) Laboratoire de Météorologie Dynamique, CNRS, IPSL, Paris, France

Current studies assessing climate engineering by stratospheric aerosol injections (SAI), like those performed in the framework of GeoMIP, reveal numerous risks and undesirable side effects of this method. But they largely rely on the assumption that increasing radiative forcing by greenhouse gases can be counterbalanced by sufficiently large aerosol injections, at least on a global scale. However, there are various processes that might have the potential to severely limit the efficacy of SAI, but which are not considered in most of the participating earth system models. Among them, there is coagulation of aerosol particles leading to an increase in particle size, which reduces scattering efficiency and stratospheric
Cirrus cloud thinning: Do the right conditions exist, and how can it be tested with observations?

D. Mitchell (1); A. Garnier (2); M. Avery (3)
(1) Desert Research Institute, Atmospheric Sciences, Reno, Nevada, United States of America; (2) UPMC–UVSQ–CNRs, Laboratoire atmosphères, milieux, observations spatiales, Paris, France; (3) NASA, Atmospheric composition, Hampton, United States of America.

This presentation will describe recent scientific developments in a phenomenon sometimes called cirrus cloud thinning, addressing (1) new evidence that supports its underlying physical assumptions; (2) a means of field testing the CI method with cirrus conditions that are representative of the environment (i.e. without cloud seeding); and (3) how to reduce uncertainties concerning its radiative and climate impacts.

While GCM testing of cirrus cloud thinning suggests it has some advantages over stratospheric aerosol injection, cirrus CI will not work when ice is primarily formed through heterogeneous nucleation for $T < -38^\circ$C. Field campaigns have shown optical and cirrus properties generally nucleate heterogeneously, but these campaigns have not addressed the cirrus at high latitudes that would determine the effectiveness of cirrus CI. A new understanding of thermal absorption in two split-window channels has rendered a reinterpretation of a standard CALIPSO satellite retrieval (the effective absorption optical depth ratio, or $\beta_{eff}$), and a tight correlation between $\beta_{eff}$ and the N/IWC ratio has been demonstrated, where N/IWC is the ice particle number concentration and aerosol’s own greenhouse effect, can limit the desired cooling effect.

Radiative transfer schemes were implemented in the IPSL climate model using an aerosol bin scheme. A new radiative transfer scheme for cirrus was used to account not only for solar, but also for terrestrial infrared radiation. Results from climate model simulations, all these processes also limit the desired cooling effect. The DOE ARM program is considering a field program for sampling wintertime Arctic cirrus ($T < -40^\circ$C) in response to these satellite retrievals due to their importance to climate science. In situ measurements of wintertime cold Arctic cirrus would enable their microphysical properties to be parameterized (i.e. cloud temperature related to effective diameter $D_e$) related to mass-weighted ice fall speed $f$ and contrasted with microphysical properties; parameterizations associated with cirrus formed at similar temperatures through heterogeneous ice nucleation. GCM simulations using these parameterizations would then be able to evaluate the actual potential climate impact of cirrus cloud seeding (i.e. cirrus CI) at high latitudes, thus reducing various uncertainties associated with cirrus CI such as its cooling impact.

Low-cost low-risk space-based geoengineering – is it possible?

A. Ellery (1)
(1) Carleton University, Mechanical & Aerospace Engineering, Ottawa, ON, Canada.

Space-based geoengineering is often discarded as an approach to geoengineering on the basis of cost and feasibility. The Angel approach is to launch modular component spacecraft into the Sun–Earth L1 point forming a solar shield to reduce the amount of solar energy incident on the Earth’s surface. The cost of an operational Space-based solar shield may revolve around the issue of launch capacity from the Earth’s surface. The proposed American lunar Resource Prospector Mission (RPM) slated for launch in 2018 offers an alternative approach – the robotic use of lunar resources to bootstrap the feasibility of lower-cost space missions by reducing the amount of launched material. We present a preliminary feasibility and technological development assessment to manufacture the modular spacecraft required to realise a modular solar shield concept. The RPM mission will be investigating the extraction and processing of lunar soil – in particular, ilmenite (FeTiO3). It may be extracted magnetically and ilmenite grains are preferentially enriched in volatiles. Although dominated by hydrogen – itself a useful reductant as well as propellant with oxygen – these volatiles include carbon compounds that may potentially be manufactured into plastics (silicone plastics in particular to conserve the carbon inventory). These volatiles may be evolved by heating the ilmenite grains to 600–650°C using a simple fractional distillation column. The ilmenite (FeTiO3) is heated in a carbonite environment (i.e. recycled hydrogen from lunar water ice or recovered volatiles) to yield oxygen, wrought iron and titania ceramic/glass (FeTiO3). In this way we may be able to manufacture the infrastructure required to form the primary interest for RPM is in the recovered oxygen to support human lunar colonisation, our interest is in the iron to form the basis of a robotic industrial infrastructure. As well as iron, cast lunar basalt offers the possibility of compressive material as sacrificial structures to conserve iron for incorporation into manufactured spacecraft structures – wrought iron is a perfectly adequate structural material. The Moon excitement for the recovered oxygen is so high that so thermal control materials will be essential in any infrastructure as well as the spacecraft modules. TiO2 is an excellent thermal (and electrical) insulator which may be coated onto fibreglass or ceramics for use in space. A thermal conduction material is required – ferronico, an alloy of iron, nickel and cobalt, is an excellent thermal and electrical conductor. Both Ni and Co may be sourced from mass concentration regions of the Moon, marking the locations of iron meteorite material. Semiconductor material – silicon is available from lunar silicates minerals. From these materials, we have the basic elements we require to build a spacecraft mechanically, electrically, electronically and thermally. The only Earth–imported reagents required for isolation of these materials are Na and Cl which nevertheless are recycled. The materials must be formed into useful structures – the processing of these materials to form 3D printing offers a versatile means of manufacturing that can handle plastics, metals and ceramics. Selective laser sintering is an approach that uses lasers to thermal fuse particles into layers, thereby forming 3D structures that cannot be manufactured in any other way. Electronics without solid state manufacturing techniques represents a particular challenge though progress has been made in printed plastic electronics. Another option is to use 3D printing.
Climate Engineering and Policy Interaction Networks: The Challenges of Regulating a Complex System

J. Lawhead (1)
(1) University of Southern California, Earth Science / Philosophy, LOS ANGELES, United States of America

The global climate is a complex system. Among other things, this means that a complete analysis of the climate as a whole requires attention to the ways in which various geophysical and biological subsystems influence and constrain one another's behavior. This fact is widely appreciated. Less widely appreciated is the fact that climate policy design and analysis involves very similar considerations. Global policy initiatives like climate engineering will not be implemented in a social vacuum, and the emerging consensus is that climate engineering would be best employed as part of a multi-faceted strategy that also involves mitigation and adaptation programs. In light of this, it is vitally important that we think about the ways in which different climate-related policies might influence and constrain one another before we begin to implement any significant global policy.

While feasibility analyses and impact studies exist for many proposed climate engineering programs, very little attention has been paid to the ways in which such programs might interact with and constrain other international and national climate policies. This paper explores this "interaction problem" from an interdisciplinary perspective, focusing on a detailed hypothetical case study in which a solar radiation management by stratospheric aerosol injection program is combined with a global system of economic carbon credits. The construction of these two programs raises practical, theoretical, and ethical concerns that don't appear when either policy is considered alone, and which might significantly alter the effectiveness and feasibility of both programs. This incomplete picture, arising from analyzing climate engineering proposals in isolation, is a potentially dangerous oversight as we move closer and closer toward possible implementation.

Response of Indian Subcontinent to the Geoengineering of Climate: The Effect of SRM on Cloud Area Fraction and Rainfall

P. Arora (1) ; SK. Mishra (2)
(1) IIT Delhi, Civil Engineering, New Delhi, India; (2) IIT Delhi, Centre for atmospheric sciences, New Delhi, India

The objective of this paper is to study the effects of Solar Radiation Management (SRM) on the climate over the Indian Subcontinent, particularly how it changes the cloud area fraction and total precipitation over the region. Cloud area fraction and precipitation are highly model sensitive parameters which depend greatly on other parameters like surface air temperature and evaporation. These parameters play a major role in the scale weather activities in any area and a small change in them can trigger repercussions on a much larger scale. As such it becomes extremely important to analyze closely the effects of SRM on the climate behavior before acting in reality. The data for five important and interdependent variables; cloud area fraction, total precipitation, precipitable water, evaporation and surface air temperature were studied exhaustively for nine models namely BNU-ESM, CCSM4, CanESM, CAM5.1, GISS-E2-R, HadGEM2-ES, IPSL-CM5A-LR, MIROC-ESM and MPI-ESM-LR, for a period of 50 years and the graphical results for the changes in these parameters were plotted, such as NC concerning Language (NCL). The results obtained from these plots were indicative of the fact that cloud area fraction and precipitation, particularly over the Indian Subcontinent, are indeed highly model sensitive parameters; where a small change in the solar radiation caused changes as high as 30% in these parameters. With the given uncertainty in the simulated parameters, it becomes crucial to have more robust modeling before implementing any decision, particularly for a country like India where the economy is largely driven by monsoon dependent agriculture and even a small change in the climate can affect severely the livelihood of millions of people. Therefore any decision, big or small, must be pondered upon carefully, to analyze the risks and the benefits being derived from it, before implementing it on a local, regional or global scale.
Injections and Marine Cloud Brightening. CDR techniques are seen as currently not effective enough, too slow and too expensive. Asked for which aspects of research should get more attention, answers differed for CDR and SRM in the way that for CDR participants identified technical research and development and economics among the main aspects; for SRM, climate effects, governance and ethics where highlighted; environmental effects and impact assessment scored high for both approaches.

3. Opinions about Field Research and Governance. Whereas several participants were in favour of no field research at all, others expected field tests for CDR and/or SRM. However, the Hooton research differed: For CDR, field tests were mainly suggested to test feasibility, efficiency, safety, impacts, solutions for carbon storage and recycling. For SRM, the main questions were related to atmospheric physics and chemistry, specifics of particles, engineering tests, delivery technology, impact assessment and critical factors. With regard to governance that should be in place before field testing, opinions differed from no governance to that existing governance is sufficient to the need for an international convention or legal framework and a global body, as well as the application of national laws. Furthermore, environmental and social impact assessments (EAI and SIA) were suggested and the need for public participation in decision making and ensuring transparency was highlighted.

On a general note, most survey participants hope that CE won’t be necessary at all and emphasized that climate change mitigation should be heavily intensified.

P-3301-03

Geoengineering, Preferred Climate States, and Climate Policy in the Anthropocene

J. Horton (1)

(1) Harvard University, Kennedy School of Government, Cambridge, MA, United States of America

Many social, ethical, political, environmental, and other objections to geoengineering have been raised since the taboo on public discussion was broken a decade ago. One of the key criticisms, though often unspoken, is focused on the fact that geoengineering would necessarily entail making conscious, deliberate decisions about desired climate states. These states might be implicit or explicit, and might be defined in terms of temperature, radiative forcing, rate of change, atmospheric concentration, or some other metric, but choosing to intervene in the climate system is inextricably linked to choosing what the climate ought to be. This feature of geoengineering has been criticized on the grounds that it is arrogant, hubristic, harmful, corrupt, and/or unwise. There may be merit in such criticisms, yet this line of argument overlooks the reality that, in the Anthropocene epoch, any climate policy is unavoidably premised on a preferred climate state. Mitigation rests inherently on targets, whether general (climate stability, preindustrial, Holocene) or specific (°C, ppm, GtC). From a philosophical point of view, any such target is ultimately arbitrary, in the sense that nature does not endorse one goal over another. The same is true of adaptation. Every potential climate state entails some combination of winners and losers (human and non-human), and the ethical dilemmas this raises cannot be avoided simply by excluding geoengineering as a climate policy option. The mere fact of making decisions about preferred climate states is an insufficient and unhelpful reason for objecting to geoengineering; the only serves to obscure the tough choices about future climate that must be made whether or not geoengineering is on the policy agenda.

P-3301-04

Geoengineering: Existing State Specific Laws and impacts upon Human Health, the Eco-system & Economics

AM. Hunter (1)

(1) Hunter Consulting, Legal, Phoenix, Arizona, United States of America

An overview of examples of and analysis therero of currently in effect state statutes on air pollution and how any proposed geoengineering, solar radiation management and/or climate intervention plans or programs would have a legal impact and effect upon associated risks such as human health, the Eco-system and state economies.

P-3301-05

Atmospheric consequences of disruption of the ocean thermocline by ocean pipe technologies

K. Lester (1) ; K. Ricke, (1) ; K. Caldeira (1)

(1) Carnegie Institution for Science, Stanford, CA, United States of America

Technologies utilising vertical ocean pipes have been proposed as a means to avoid global warming, either by providing a source of clean energy, increasing ocean carbon uptake, or storing thermal energy in the deep ocean. However, increased vertical transport of water has the capacity to drastically alter the ocean thermocline. To help bound potential climate consequences of these activities, we performed a set of simulations involving idealised disruption of the ocean thermocline by greatly increasing vertical mixing in the upper ocean. We use an Earth System Model (ESM) to evaluate the likely thermal and hydrological response of the atmosphere to this scenario. In our model, increased vertical transport in the upper ocean decreases upward shortwave and longwave radiation at the top-of-the-atmosphere due primarily to loss of clouds and sea-ice over the ocean. This extreme scenario causes an effective radiative forcing of about 15.9 W m⁻², with simulations behaving on multi-decadal time scales as if they are approaching an equilibrium temperature change of about 8.6-8.8°C higher than controls. Within a century, this produces higher global mean surface temperatures than would have occurred in the absence of increased vertical ocean transport. In our simulations, disruption of the thermocline strongly cools the lower atmosphere over the ocean, resulting in high pressure anomalies. The greater land-sea pressure contrast is found to increase water vapour transport from ocean to land in the stronger atmosphere and therefore increase global mean precipitation minus evaporation (P-E) over land; however, many high latitude regions and some low latitude regions experience decreased P-E. Any real implementation of ocean pipe technologies would damage the thermal structure of the ocean to a lesser extent than simulated here; nevertheless, our simulations indicate the likely sign and character of unintended atmospheric consequences of such ocean technologies. Prolonged application of ocean pipe technologies, rather than avoiding global warming, could exacerbate long-term warming of the climate system.

P-3301-06

Perspectives of Climate Engineering Adoption in Africa: Analogies from International Environmental Agreements, Conventions and Treaties

C. Ngonzo Luwesi (1) ; AA. Rose (2)

(1) Kenyatta University, Geography, Nairobi, Kenya; (2) Kenya Forest Service, Climate change response programme, Nairobi, Kenya

Global warming is steadily threatening ecosystems and their biological lives across the globe. Though life in the equatorial and tropical regions is associated with hot temperatures rather than cooling, the drastic decrease of forest cover and major vegetation changes in the last century may be an argument for adoption of the principle of large-scale Climate Engineering (CE). Whether through Solar Radiation Management (SRM) or through Carbon Dioxide Removal (CDR), this strategy might only be acceptable as a “plan B” to climate mitigation and adaptation. CE research and technology may be scaled up to supplement African governments’ efforts to reduce planned greenhouse gases (GHG) emissions and avoid suicidal climate mitigation and adaptation strategies. These schemes are cheap and effective climate “mitigation” options but may be dangerous, the safest options being expensive or simply useless. Besides, most of the current African continent do not have the ability to invest in what are considered as “harebrained schemes, which impacts are yet to be ascertained”. Hence, African countries will recourse to several principles found in the UNCCD, UNCBD and UNFCCC treaties and conventions, the REDD+ agreement, and the 1997 UN Convention on International
Public perceptions of climate engineering and field test proposals in Japan

M. Sugiyama (1); S. Asayama (2); A. Ishii (3)

(1) The University of Tokyo, Policy Alternatives Research Institute, Bunkyo-ku, Tokyo, Japan; (2) National Institute for Environmental Studies, Japan, Tsukuba, Japan; (3) Tohoku University, Center for northeast asian studies, Sendai, Miyagi, Japan

There is a growing call for research on climate engineering, the deliberate intervention into the Earth’s particularly stratospheric aerosol injection (SAI), one of the methods of so-called solar radiation management (SRM), given the presumed inadequacy of global efforts to reduce greenhouse gas emissions and a possibility of a climate emergency. Such a call for research on SAI includes proposals of conducting small-scale outdoor experiments or field tests in the natural environment with controlled emissions of aerosols.

However, there are strong disagreements and controversies among scientists on whether and how such field tests should proceed, and this debate is mainly based not on technical but social, political and ethical concerns. Advocates claim the urgent need for field tests due to concerns over “climate emergency” while critics worry about “moral hazard” caused by field tests and argue that once research was initiated, SAI would fall down a “slippery slope,” eventually leading to its deployment. These concerns are relevant to broader public deliberation, and should not be confined only to debate among experts.

In this poster, we report the results of a recent online survey with Japanese citizens (N = 3000), focusing mainly on field tests. Our design aimed at elucidating the key social, political and ethical concerns of the public regarding SAI and answered their opinions.

The survey results show a high rate of the “unsure” or “don’t know” (DK) responses — about one-third of the respondents chose DK response to the questions regarding attitudes toward SAI. At least three reasons can be considered as sources of DK response: first, lack of knowledge and awareness of SAI, as nearly two-thirds answered “neither heard of nor know at all SAI”; second, little understanding of the provided information of SAI, since about two-fifths of the respondents answered “cannot understand so much” or “cannot understand at all”; and third, the omission of middle scale option such as “neither agree nor disagree,” which might cause those who have ambivalent or ambiguous views on SAI to be difficult to answer, resulting in a DK response. Thus, our survey results can be deemed to show the public’s undecided opinions on SAI.

Nevertheless, the respondents demonstrated discernible attitudes toward SAI in some respects. First of all, a great majority of the the respondents clearly favor mitigation to SAI, and think that considering SAI before pursuing all efforts to reduce CO2 emissions is undesirable. In addition, the respondents expressed concerns over the potential risks of field tests, but differentiated different modes of research. They demonstrated preference of indoor research activities such as computer simulations and lab work over outdoor field tests. The support for the deployment of SAI at all, as well as support for the deployment of SAI at all, was consistent with the findings of previous surveys. The respondents also showed a relatively serious concern over the risk of unpredictable side-effects of SAI and potential consequences of research, i.e. the “slippery slope”, although a majority of them thought that the prospect of “moral hazard” is unlikely. Regarding the governance issues on field tests, the respondents strongly favored a public consultation before field tests, as well as disclosure of the results including negative information, and the international regulation of field tests instead of scientists’ self-regulation. The respondents seem to endorse the importance and significance of “Oxford Principles” of climate engineering research governance.

In our survey we controlled the information of SAI and split the sample into one with and without the “climate emergency” frame. Previous research suggests that framing of information provided to the respondents (especially, emergency framing) may influence, and therefore bias the SAI-related perceptions. Our SAI, though the respondents of our survey did not yield such framing effects on respondents’ attitudes toward SAI with any statistical significance. We thus have reported all the results, collapsing the two groups into one.

We believe our survey results can bring important and non-Western perspectives into the wider public debate on climate engineering.
of proposed CDR. At present the proposed simulations for CDR-MIP include: Direct-air capture simulations, Afforestation and Ocean alkalisation as well as a modified Diagnostic, Evaluation, and Characterization of Klima (DECK) experiment. These experiments are designed to answer key questions related to quantifying efficacy, feedbacks, response time scales, and potential side effects of specific CDR methods, as well as questions of climate “reversibility”. Here we present details on the proposed experiments, and encourage feedback from the community on their design and implementation. It is anticipated that this will be the first stage of a continuing project exploring CDR, and as such we strongly encourage interested modeling groups to participate. CDR-MIP aims to commence in September 2015.

3302 - Key Energy Technologies for Low Carbon Pathways

ORAL PRESENTATIONS

K-3302-01
The Role of Technology for Achieving Climate Policy Objectives: Overview of the EMF27 Study

E. Krieger (1) ; V. Krey (2) ; J. Weyant (3)
(1) Potsdam Institute for Climate Impact Research, Potsdam, Germany; (2) IIASA, Laxenburg, Austria; (3) Director, Energy Modeling Forum (EMF), Stanford, CA, United States of America

Low-carbon technologies in the energy system have been identified as a key element for mitigating climate change. The relative importance of mitigation technologies depends not only on their techno-economic characteristics and how they develop in the future, but also on the competition with other energy technologies, the development of future energy demand and the climate policy architecture. Since all of these factors are interconnected and surrounded by large uncertainty, it is important to investigate technology strategies from a system perspective and under a variety of assumptions.

This presentation gives an overview of results from the Stanford Energy Modeling Forum Study 27, an inter-comparison of 18 energy-economy and integrated assessment models. The study investigated the importance of individual mitigation options such as energy intensity improvements, carbon capture and storage (CCS), nuclear power, solar and wind power and bioenergy for climate mitigation. Limiting the atmospheric greenhouse gas concentration to 450 or 550 ppm CO2 equivalent by 2100 would require a decarbonization of the global energy system in the 21st century. Robust characteristics of the energy transformation are increased energy intensity, improvements in energy conversion and the electrification of end use coupled with a fast decarbonization of the electricity sector. Non-electric energy end use is hardest to decarbonize, particularly in the transport sector. Technology is a key element of climate mitigation. Versatile technologies such as CCS and bioenergy are found to be most important, due in part to their combined ability to produce negative emissions. The importance of individual low-carbon electricity technologies is more limited due to the many alternatives in the sector. The scale of the energy transformation is larger for the 450 ppm compared to the 550 ppm CO2e target. As a result, the achievability and the costs of the 450 ppm CO2e target are more sensitive to variations in technology availability.

K-3302-02
Innovation in Renewable Energies and their contribution to combat climate change

P. Frankl (1)
(1) IEA, France

Not communicated.

K-3302-03
Is nuclear energy part of the solution?

V. Faudon (1)
(1) Société Française d’Energie Nucléaire, Paris, France

At least 80% of the world’s electricity must be low-carbon by 2050 to keep the world within 2°C of warming, according to the IPCC. This is a massive global challenge that requires the use of all available low-carbon energy technologies. Nuclear energy is recognized by the IPCC as “an effective greenhouse gas mitigation option with life cycle emissions ‘comparable to most renewables’.”

We need to take immediate steps towards reducing greenhouse gas emissions, as the world has already used up most of its carbon budget. Nuclear energy is low-carbon, available and competitive in the timeframe required. It has avoided the release of 56 gigatons of CO2 since 1971, two years’ worth of emissions at current rates. Additional nuclear energy capacity can be built up in the world’s largest emitting countries: there are more reactors under construction today than at any time in the last 25 years with BRICS countries leading the way.[1] Existing nuclear power plants are the largest low-carbon electricity source in OECD countries. Operating them for longer is one of the most effective ways to keep greenhouse gas emissions down. Moreover, nuclear generation can operate with renewables in order to adapt generation to electricity demand, taking into account variability of certain renewable energy sources.

As countries are pursuing different energy policy goals, with different constraints, they should be free to choose from the full portfolio of energy technologies, including renewable energies and nuclear energy, to reduce CO2 and meet other energy objectives. Very few scenarios have been investigated with mitigation requirements linked to warming to 2°C and implementation of a nuclear phase out. While the need for the largest portfolio now: nuclear research should receive support to develop future reactors (generation 4) that will make better use of the Uranium resources, will operate in a safer way, and produce less waste. Renewable energies and Nuclear have to be considered together as part of the electricity mix on the low carbon pathways.

3302-POSTER PRESENTATIONS

P-3302-01
Ocean Thermal Energy Conversion, the potential impact on microplankton of bottom water discharge at subsurface

M. Boye (1) ; M. Giraud (2) ; V. Garçon (3) ; M. Lejart (4) ; C. Auvray (5) ; M. Boeuf (4) ; D. De La Broise (6)
(1) Institut Universitaire Européen de la Mer, Laboratoire des Sciences de l’Environnement Marin, Plouzané, France; (2) IUEM-LEMAR, FEM, LEGOS, Brest, France; (3) LEGOS, UMRS566, Toulouse, France; (4) France Energies Marines, Brest, France; (5) DCNS, Brest, France; (6) IUEM-LEMAR, Plouzané, France

Part of the solar energy can be harvested and used in different processes. Taking advantage of the natural temperature gradients between surface and the deep ocean, the Ocean Thermal Energy Conversion (OTEC) process achieves this goal. However, the artificial upwelling created by the release of deep water flowing out of an OTEC plant into the sub-surface layer (whose temperature and biogeochemical composition are quite different) could locally induce alterations in ecosystem structure and functioning. The anticipated effects on the micro-phytoplankton were studied on a scheduled pilot site off Martinique (Caribbean Sea), within the framework of the IMPALA project.

The biogeochemical processes that participate in the artificial upwelling were addressed by simulation of the discharge using in situ microcosm experiments immersed
for 6 days. Mixing of deep water with sub-surface waters was achieved by an increase in chlorophyll (maximum of chlorophyll and bottom of the nutrient line) and mixing rates (0%, 2% and 10% of bottom water). Analyses of pigments (HPLC, picophytoplankton abundance (flow cytometry), and nutrients were performed in the microcosms and the surrounding waters to assess the natural variability of the phytoplankton assemblage and the potential shifts induced by rich deep water supply in a nutrient poor surface water.

Similar evolution over time of the phytoplankton communities was observed in the natural environment and in the microcosm without deep-water input, suggesting that microcosms can be used to assess the impact of bottom water discharge at sub-surface. The enrichment of sub-surface waters by 10% of deep seawater induced a significant shift in the phytoplankton assemblage towards the development of diatoms. This could have biogeochemical and ecological consequences since diatoms are major drivers of the biological carbon pump in the ocean.

P-3302-02
The potential of nuclear energy to mitigate climate change

FM. Breon (1); A. Berger (2); B. Brook, (3); P. Hansen, (4); F. Livet, (4); H. NiBeneeker (5); M. Petit, (4); G. Pierre (6); H. Prevot, (4); S. Richet, (4); H. Safa, (7); M. Scheneberger, (4)

(1) IPSL, CSIC, Gif sur Yvette, France (2) Université Catholique de Louvain and Earth life institute, Louvain la Neuve, Belgium; (3) University of Tasmania, Hobart, Australia; (4) Sauvons le Climat, Paris, France; (5) Sauvons le Climat, Villafranche, France; (6) Bourgogne Université Jean Monnet, France; (7) Commissariat à l’Energie Atomique, Direction de l'énergie nucléaire, Gif sur Yvette, France

In the 2014 IPCC report, Working Group 3 discusses several scenarios that are consistent with RCP-2.6, with the objective of limiting the global mean surface temperature increase to less than 2 degrees. All these scenarios rely on a significant contribution from nuclear energy to meet the 10 GtC level while the few existing experiments are at the MtC level. It may appear unreasonable to assume that the geological, technology, and cost requirements associated to CCS will be met.

We focus on the scenarios IMAGE, developed by the NEAA, Netherlands, and MESSAGE developed by IIASA, Austria. Both propose three sub-scenarios: (i) Supply that assumes a high energy consumption compliant with the needs of economic and social development. (ii) Efficiency which assumes a 45% small consumption, and (iii) Optimal which is intermediate. All 6 scenarios assume a massive development of PhotoVoltaic (PV) energy together with a large increase of biomass. In the supply scenario, 7000 MtC of carbon are put in operation between 2020 and 2100. We suggest that the urgency of climate change argue for such development as early as 2020.

We shall describe in detail the potential and limitations of such massive nucleare development. The technology for a massive nuclear development is much more mature than that of CCS, does not suffer from the intermittency limitations of PV and wind energy, and necessitates far less material extraction than these. It requires however the generalization of breeding reactors of which only a few units currently exist. The necessity for Plutonium availability is a partial shift from a Pressurized Water Reactor (PWR) to CANDU-like reactors together with the development of fuel processing facilities.

A wide development of nuclear energy, at a pace comparable to its development in France during the 70s and 80s would allow the stabilization of atmospheric CO2 concentration at a level compatible with RCP-2.6, while providing an energy source for hydrogen production and without the hypothetical massive development of CCS. It makes possible a near-total ban of coal use well before the end of the century.

P-3302-03
Analysis of substitution trade-offs among selected bioenergy pathways for different end-uses

S. Chigullapalli (1); AB. Rao (2); A. Patwardhan (3)

(1) Indian Institute of Technology Bombay, Climate Studies, Mumbai, Maharashtra, India; (2) Indian Institute of Technology Bombay, Ctara, Powai, Mumbai, India; (3) Indian Institute of Technology Bombay, Sjm som, Mumbai, Maharashtra, India

The environmental concerns (local and global) as well as the depleted reserves of the conventional energy sources have forced us to seek fuel efficient and greener alternatives for many of the traditional bioenergy approaches. Bioenergy is the traditional source of energy with renewed interest due to its carbon mitigation potential assuming CO2 neutrality, need for diversification of energy sources, and the remarkable nature of feedstocks. A bioenergy system or bioenergy chain / route consist of a series of conversion steps by which raw biomass feedstock is transformed into a final energy product (heat, electricity, or transport biofuel). There are many bioenergy chains that result in the wide range of raw biomass feedstocks (wood, grass, oil, starch, fat, etc.), broad spectrum of conversion technologies and a variety of possible end–uses.

Bioenergy alternatives offer significant carbon mitigation potential (CMP), provided that the resources are utilized sustainably and that efficient bioenergy systems are used. Certain current systems and key future options including use of biomass residues and wastes and advanced conversion systems are able to deliver 80 – 90% emission reductions compared to the fossil energy baseline [IPCC, 2012].

The CMP associated with specific bioenergy options depend on intrinsic factors such as design of the bioenergy system and extrinsic factors such as source of biomass and fossil fuels they are replacing. Many bioenergy pathways can be used to convert a range of biomass feedstock into a final energy product. The choice of bioenergy option will affect the amount of GHGs we put in the atmosphere in the near future and for years to come.

In order to assess and compare the economic and environmental sustainability of modern bioenergy systems, there is a need for comprehensive assessment of each bioenergy pathway for cataloguing attributes of various proposed bioenergy options, and their effects. This article analyzes the substitution trade-offs among selected bioenergy pathways for different end-uses.

P-3302-04
The hydrogen economy: a failed concept or the future for our energy system?

P. Dodds (1)

(1) University College London, UCL Energy Institute, London, United Kingdom

Hydrogen has been proposed since the 1970s as a clean alternative to carbon–based fuels, particularly for the transport sector. This paper examines recent developments in the use of hydrogen in transport, heat provision and energy storage, and considers policy initiatives that are designed to introduce hydrogen–powered technologies into existing energy systems.

After much hype in the early 2000’s, a perceived lack of progress led many to deem fuel cell vehicles (FCVs) a failure; research programmes were cut and attention switched to battery vehicles, encompassed within a broader view of predominantly electrically–powered energy systems. Yet many automotive manufacturers have continued developing FCVs, particularly in Asia, and have pushed in recent years for hydrogen–fuelled vehicles to have an important role in the future, for example through the publication of the McKinsey–coordinated “Power–trains” study [1]. It has had a significant impact, with government–industry H2Mobility programmes set up in several European countries to facilitate the introduction of FCVs. When combined with the recent launch of the first commercial FCV in Korea, and the unexpectedly poor sales of battery vehicles, it appears that FCVs will soon appear in many countries.

Another potential use of hydrogen that has received little attention is to decarbonise the energy sector, particularly in those countries using natural gas combusted in boilers. Natural gas is difficult and expensive to decarbonise because the emissions cannot be captured and alternative technologies (for example, electrically–powered heat pumps) are much more expensive to buy and operate,
take more space within houses and provide an inferior customer experience. Hydrogen, on the other hand, uses a similar boiler and is carbon-free. We have examined the potential for hydrogen to be supplied to homes using existing gas network infrastructure, which would greatly reduce the costs of a heat transition and would avoid such infrastructures becoming stranded assets. We have identified the circumstances in which hydrogen could replace 20–100% of existing gas heating.

A third use for hydrogen is to support low-carbon electricity generation. Power-to-gas uses excess renewable generation to produce hydrogen that is injected into existing gas networks to partially gasify the grid, so acting as a form of energy storage. Such systems are already being tested in Germany. We have assessed the value of power-to-gas to support wind generation in the UK, compared to other novel energy storage technology options.

The “Hydrogen’s Value in the Energy System” project has been assessing the value of hydrogen in all of these markets. Hydrogen is unusual as it is a zero-carbon alternative energy carrier to electricity. Our techno-economic energy system models have shown that the trade-offs between using electricity and hydrogen depend on the relative generation costs and on the net CO2 emissions from hydrogen production. We will demonstrate the importance of these trade-offs in this talk.

Innovation theory has shown that most novel technologies require support in the early stages of commercialisation in order to develop supply chains and reduce manufacturing costs through “learning by doing”. Most hydrogen production and fuel cell technologies are currently unable to compete economically with incumbent energy technologies, but could do so in the future if further cost reductions are achieved (1). One obstacle to government support for these technologies is the perception that while hydrogen is zero-carbon, the processes that produce hydrogen release CO2 emissions that are incompatible with the transition to a low-carbon economy. The lack of a UK definition of “green” hydrogen is a particular obstacle to policy support. We will conclude with an overview of how such a standard could be defined.


P-3302-05

Renewable Technologies in Karnataka: Jobs Potential and Co-benefits

R. Kattumuri (1)

(1) Grantham Research Institute & India Observatory, London School of Economics, London, United Kingdom

Green technologies provide an essential starting point towards transformation for resource efficiency and a more socially inclusive low-carbon economy. As their share in the economy increases, it can hasten the required transition towards a low greenhouse gas (GHG) emissions development–path in a cost–efficient manner (UNFCCC, 2011). Beyond making the case for early climate change mitigation policy through the development and deployment of green technologies, an assessment of co-benefits emphasises the potential of integrating climate change mitigation policies with other socio-economic targets such as improved health and social inclusion (Stern, Kattumuri and Rydge, 2012). Thus there are great opportunities and benefits to investigate, invest for innovation and development of green technologies in emerging economies.

This study, based on empirical study of examples of off-grid solar, wind energy and a few household sources of energy in the state of Karnataka, assesses the key opportunities and challenges presented by the transition to a low–carbon economy by accounting for both the creation of green jobs and the co–benefits arising from the transition of traditional energy technologies in the state. In line with UNEP’s recognition that the “greening of economies has the potential to be a new engine of growth” (2011:16) we find that a green economy may provide the necessary stimulus for a more socially inclusive development path (ADB, 2013) where co-benefits are crucial. Our research, is the first of its kind in India. It is based on primary data from households, private companies and NCGOs based in Karnataka, derives estimates for jobs potential using local employment factors in Karnataka and shows strong evidence of opportunities for jobs potential.

The main objectives of the study are:

1. Identify specific renewable technologies being developed and deployed in Karnataka
2. Review the potential for green jobs in some renewable energy sectors through quantitative analyses of case studies
3. Analyse the potential co-benefits of these renewable technologies
4. Discuss the scope of these renewable technologies and other activities that can contribute to this inclusive development and contribute its share to national greening economy targets.

Our analysis highlights the ways in which the development and deployment of green technologies facilitate reductions in inequality through social co–benefits that are necessary for transformation at the economic and social levels, in addition to the immediate environmental benefits that derive from this transition. The analyses based on the state of Karnataka can provide learnings for other states in India and elsewhere.

P-3302-06

The learning curve for wind energy in China: Lessons for climate finance

Y. Liu (1)

(1) Ecole Polytechnique, Department of Economics, Palaiseau, France

Reducing greenhouse gases emissions is a two-way street that bridges finance and technology. The key issue of global climate finance is to unlock and scale up additional and predictable capital. Meanwhile, promoting renewable energy is a distinct part of the global climate regime. It is then natural to ask how climate finance interlinks with technology policy to achieve long–term environmental and energy targets.

The theory of the learning curve suggests that the cost of renewable technology falls along with knowledge accumulation based on learning–by–doing and research and development (R&D). Understanding how this endogenous technological change has important climate policy implications in two aspects. First, the optimal abatement path may vary depending on the channels of technology cost reduction. The existing literature concludes that when knowledge is gained through R&D investments, some abatement is shifted from the present to the future, but if the knowledge–growth is learning–by–doing, the impact on the timing of abatement is analytically ambiguous (Gould and Mathai 2000). Second, governments need to investigate how, if at all, climate finance can be structured in a way to provide investment subsidy necessary to make renewable energy deployment competitive with an incumbent technology.

In this study, we first assess the learning rate of China’s wind energy by considering two sources of learning effect – cumulative installed capacity and technology efficiency improvement. Then, we extend the learning curve model to investigate the drivers and the optimal capital subsidies needed to achieve grid parity of wind electricity and the distribution of this learning investment, depending on three factors – learning rate, cost target, and deployment space.

Finally, we estimate the implicit abatement cost accordingly.

Our contribution is mainly two–fold. First, we contribute to the learning rate estimates with an empirical analysis of wind energy in China. (Ek and Soderholm 2013 and Del Rio and Tarancon 2012) provide a literature review on the learning rates of wind energy. Overall, the existing literature provides few uniform conclusions. A doubling of the cumulative wind power capacity could induce cost reduction from 33% to 3%. All these studies are focused on industrialized countries. To our knowledge, only one study estimates the learning rate of wind energy in China, using the bidding electricity prices of national wind project
concession programs from 2003 to 2007. Relying on a more comprehensive panel dataset from 2004 to 2011, our study looks at the capital cost of wind projects.

Second, our quantitative analysis contributes to the current debate on a post Kyoto regime of global climate finance. We propose a new mechanism by which upfront learning investment sets up a consistency between climate finance and technology target, and thereby the leverage role of climate finance can be monitored at the sectoral level. This proposal can address two main challenges of climate finance. Uncertainty of carbon revenue calls into question the result-based approach of climate finance, which only intervenes at the project operational stage, and therefore does not generate upfront financing, much needed notably in the developing world. Another feature of global climate finance is to balance the fairness of effort sharing. Moral hazard can generate perverse incentive for firms and governments to delay or relax environment and energy policies (Millard-Ball and Kerr 2012). In fact, the debate on the additionality of climate finance has been triggered with respect to China’s wind power projects supported by a policy mix including feed-in tariff (FIT) and Clean Development Mechanism (CDM) (Liu 2014). Actually, new market mechanisms for Post-Kyoto shift towards a sectoral approach of cooperation with most of developing countries (WFC 2013; Deutsche Bank 2011). Most of these initiatives are still at a conceptual level, while our analysis is quantitative and evidence-based, and thus provides a useful support to these initiatives.

P-3302-07

Electrochemical systems for a circular economy energy and carbon reuse: the SOFCOM pilot plant

M. Santarelli (1) ; A. Lanzini (1) ; M. Gandiglio (1)
(1) Politecnico di Torino, Energy, Torino, Italy

In the framework of the EU project SOFCOM (FCH JU Grant agreement no: 278798) POLITO has developed a proof-of-concept devoted to demonstrate the high interest of electrochemical systems based on high temperature fuel cells to operate as the core of future energy systems with renewable fuels and multi-product configuration, with particular care on CO2 management through C re-utilization in different processes (electrochemical, chemical, or biological as in SOFCOM).

The proof-of-concept SOFC system, installed in Torino (IT), operates with biogas produced in an industrial waste water treatment unit (WWTP) in CHP configuration, and with the CO2 separation from the anode exhaust sent to a section of CO2 recovery for Carbon reutilization in a photo-bio-reactor for storage in form of algae (CO2 sink). Therefore, the proof-of-concept demonstrates a poly-generation system based on the use of renewable fuels (biogas) in high efficiency electrochemical CHP generators, with complete CO2 recovery and Carbon reuse. The four products are:

1. High efficiency electric power from SOFC;
2. Thermal recovery from SOFC and other processes in the plant;
3. Clean water from photo-bio-reactor;

From a more strategic point of view, the proof-of-concept demonstrates how electrochemical-based systems could represent an important cornerstone of future energy systems based on renewable fuels, with the highest achievable energy conversion efficiency, and the total recovery of main energy-related elements (C, H, O) possibly towards a material closed cycle.

The concept of completed energy and material recovery (in particular, Carbon recovery) points towards a concept of circular economy of energy, with negative CO2 emissions: the Carbon atom is completely recirculated in the system, and its re-utilization can be looped virtually for an infinite time.

The concept demonstrated by the proof-of-concept is completely replicable in similar context, or in completely new context in which the Carbon recovery will become a must. The impacts are now at the local level (where the demonstration is applied) but in principle the impact of these typologies of systems (with complete Carbon reuse) could be at global level once adopted.

The concept, and its proof-of-concept, will be discussed in the presentation.

P-3302-08

Hydrodynamic modeling of the hydraulic threshold El Haouareb

A. Sebai (1)
(1) National Agronomic Institute of Tunisia, Tunis, Tunisia

Groundwater is the key element of the development of most of the semi-arid areas where water resources are increasingly scarce due to an irregularity of precipitation, on the one hand, and an increasing demand on the other hand. This is the case of the Central Tunisia region, object of the present study, which focuses on an implementation of an underground flows hydrodynamic model to understand the recharge processes of the Kairouan’s plain groundwater by aquifers boundary through the hydraulic threshold of El Haouareb.

The construction of a conceptual geological 3D model by the Hydro GeoBuilder software has led to a definition of the aquifers geometry in the studied area thanks to the data acquired by the analysis of geologic sections of drilling and piezometers crossed shells partially or in full. Overall analyses of the piezometric Chronicles of different piezometers located at the level of the dam indicate that the influence of the dam is felt especially in the aquifer carbonate which confirms that the dynamics of this aquifer are highly correlated to the dam’s dynamic. Groundwater maps, high and low-water dam, show a flow that moves towards the threshold of El Haouareb to the discharge of the waters of Ain El Beida discharge towards the plain of Kairouan.

Software FEFLOW 5.2 steady hydrodynamic modeling to simulate the hydraulic threshold at the level of the dam El Haouareb in a satisfactory manner. However, the sensitivity study to the different parameters shows equivalence problems and a fix to calibrate the limestones’ permeability. This work could be improved by refining the timing steady and amending the representation of limestones in the model.
The bet on renewable energies is a key aspect of the mitigation efforts aimed at abating climate change, in which Europe is a world leader. In particular, PV power has been receiving large investments and its future deployment is expected to be spectacular, especially in southern countries. However, without development plans remaining widely blind to the potential impacts of a hereafter changed climate on renewable energy resources. In order to shed light on this issue, this study makes use of a new generation multi-medium model—scenario ensemble of high-resolution climate simulations spanning up to the end of this century to assess changes in both PV power generation potential (PVpot) and actual production (PVprod) considering a future scenario with a high penetration of PV installations. Results show that the projected increase in the surface air temperature adversely affects the projections for PVpot, as it acts to diminish the efficiency of the PV cells. Thus, while surface solar radiation is projected to slightly increase in southern regions, PVpot is not. In the most extreme scenario considered (RCP8.5), PVpot would diminish in the range 5–15% (from South to North within Europe) by the end of this century according to the ensemble mean. In terms of production, significant changes are not expected southward but for a plausible reduction of the daily variability of the PVprod series, which would indeed be beneficial. However, further north, worse projections, with the Scandinavian region holding robust reductions in the mean production (about 10% under the RCP8.5) and uncertain projections regarding its future variability, in addition, the models depict limited impacts in local climate change. The latter finding suggests that climate change does not seem to pose a serious risk for the PV sector in Europe.

O-3303-02

Advances in multi-scale models to shed light on the plausibility of longterm scenarios

N. Maïzi (1)

(1) PSL, MINES ParisTech, Mathematics and Systems, Center for Applied Mathematics, Paris, France

Given the complex international situation, mitigation strategies to tackle energy-related issues need effective normative tools to deal with the different types of constraints (e.g. climate-related, financial, legal, political, technical). Various scenarios are now available to provide an insight into the challenges of energy transition under environmental constraint. However, the regional, technological, and social decisions that trigger this transition require developing tools to identify the policy mixes needed for new directions in technical systems and modes of development. And this is more stringent in the electricity sector.

In particular, the aim is to reconcile and connect different scales (temporal, spatial, social) in order to understand:

- The political implications that necessarily take place at several levels, from global to local,
- The impact of phenomena with different dynamics (several decades versus seconds), and
- The central role of people (for whom the future must be acceptable and desirable, i.e. compatible with aspirations and behavior).

This multi-scale integration brings up significant methodological obstacles that we propose to examine in three stages to understand the needed reconciliation of long-term approaches employed in prospective exercises at different scales:

1. Short-term/long-term temporal scales: reconciliation involves examining the ‘inertia’ of systems, e.g. urbanization or the composition of current mixes, versus the ‘instantaneity’ of usage (e.g. mobility using electric vehicles or smart grid solutions, energy efficiency) as well as the technical conditions for operating systems (i.e. network reliability, availability and stability);

2. Spatial scales: different levels of spatial issues will be tackled such as top-down versus bottom-up pledges for emerging countries, centralized versus decentralized networks, managing intermittent electricity production sources and integration into the network;

3. Societal scales: this will involve discussing the assessment of different development paradigms (degrowth/growth) and the integration of behavior as relevant modeling characteristics.

Each issue will be illustrated using specific examples.

O-3303-03

Using big data to make decisions in the electricity sector under deep uncertainty

I. Azevedo (1); I. Azevedo (2); B. Sovacool (3); K. Jones (4); M. Dworkin (5)

(1) Carnegie Mellon University, Engineering and Public Policy, Pittsburgh, PA, United States of America; (2) Carnegie-Mellon University, Department of engineering and public policy, Pittsburgh, United States of America; (3) Danish Center for Energy Technologies (Center for Energiteknologi), Herning, Denmark; (4) Vermont Law School, Vermont law school, South Royalton, United States of America; (5) Institute for Energy and the Environment, Vermont law school, South Royalton, United States of America

Creating resilient, reliable, and low-carbon electricity systems to help mitigate the effects of greenhouse gas emissions and adapt to a changing climate remains a critical global challenge.

Electricity consumption accounts for a large portion of greenhouse gas emissions worldwide, making it one of the key drivers for climate mitigation strategies. Decarbonizing the electricity system becomes an even more daunting task given about 17% of the world population does not yet have access to energy services.

Changes in the electricity sector to move towards a low carbon energy system leave to important trade-offs in terms of costs to the overall energy system, how such costs are distributed, how to address issues related to fuel security and diversity, how to improve the level of energy services provided, and environmental consequences.

While decisions regarding different strategies to decarbonizing electricity systems may be done under deep uncertainty, in recent years the emergence of very detailed data, i.e., the big data revolution, paired with big data analytics – provides the ability to draw new insights and new ways to approach decisions.

This talk will focus on the ability to make decisions in the electricity sector under deep uncertainty in the United States. In the United States, the data from the Continuous Emission Monitoring System (CEMS), which is collected and made publicly available by the U.S. Environmental Protection Agency, provides data regarding the hourly power generation, and emissions from GHGs and criteria air pollutants, for every single fossil fuel based generator in the United States that is larger than 25MW. This data, coupled with air quality models and health and environmental valuation models, allows us today to estimate the regional effects of different interventions in the U.S. grid (such as increasing renewable (Siler-Evans et al., 2012; 2013), building codes (Gilbraith et al., 2014), storage (Hittinger and Azevedo, 2015) in a way that was not possible before. Similarly, on the consumption side, the deployment of smart meters coupled with information on energy efficiency and demand side management programs provide a new way to use big data analytics to assess whether the intended goals of the programs have been achieved (Azevedo, 2014).

In this session, we will (1) provide an overview of some of the recent big data analytics efforts that have been pursued to improve decision making under uncertainty in decisions aiming at the decarbonization of the electricity sector in the United States; (2) provide a map of data needs for the national grid across the world that would be critical for one of the above to perform systematic international comparisons; (3) provide a research roadmap of the critical research questions we believe need to be addressed to make better decisions under uncertainty in the electricity sector.

References:


Siler-Evans, K., Azevedo, I. L., Morgan, M.G, Apt, J.
Integrated pathway to decarbonizing electricity in China

S. Fu (1) ; Q. Yameng (2)
(1) Chongqing University of Arts and Sciences, Chongqing, China; (2) University of Tampere, School of Information sciences, Tampere, Finland

1. Background: Economy, electricity and carbon mitigation in China

The momentum of economy growth is strong. i) urbanization; ii) poverty; iii) all-round Open-up and Reform policy; iv) 6.5-7.5% growth rate during 2016 to 2020.

Power industry faces rigorous environmental challenge. Per capita electricity is 3510 KWH and will continue to rise sharply. Energy-intensive industries are backward, which results in low energy efficiency. As 78% electricity comes from fossil fuel, CO2 intensity remains 0.514-1.246 tCO2e/MWh. Power industry discharges 39% CO2 and still appears upward trend. Pricing and universal services are far from perfect; moreover, institution has CO2 lock-in weakness.

Carbon mitigation achievements in power industry. Energy intensity per unit GDP dropped by 20.7%, reducing 1.967 million tCO2e. Non-fossil energy accounted for 8% of primary energy consumption, saving over 600 million tCO2e annually. China eliminated 80 million KW small thermal power units, reducing 166 million tCO2e every year. What more, innovation of generating technology and reformation of institutional arrangement contributed to huge CO2 abatement.

2. A big deal: China–U.S. Joint Announcement on Climate Change

Benefits and protocol. Smart action on climate can promote economic growth and broad benefits. China–U.S. will jointly propose a protocol under the COP21.

Post–2020 actions. The U.S. targets to reduce CO2 by 26–28% in 2025. By 2030, China will peak CO2 emission and increase the share of non–fossil fuels to 20%.

Technology cooperation. China–U.S. have a robust program of energy technology cooperation and will jointly invest more in clean technological innovation.

Policy dialogue and practical cooperation. The two sides announced additional measures to strengthen and expand practical cooperation in climate change.

3. Integrated pathway option: Decarbonizing electricity in China

Decarbonizing electricity goal. Chinese electricity need follow a path featuring high efficiency, less pollution as well as satisfying economy growth. At 2015 energy intensity will drop by 16% and CO2 decrease by 17%. At 2020 non–fossil energy will take 15% and CO2 lower by 40–45%.

Demand side management. China adopts key actions in electricity–saving among industry, building and transportation; actively transforms economy into capital– and technology-intensive mode. It lists technologies of energy–saving and sets energy intensity standard. China encourages green building, improves heat–supply as well as electricity–saving by public building. It also promotes green transportation, electricity–saving education; therefore, fosters a green lifestyle.

Develop renewable electricity. Renewable power is to take 30% by 2015. Hydropower will get 290 million KW, half of its potential. Currently nuclear power is 1.8%; thereafter China will endeavor to reach 40 million KW. It stresses intensive and distributed exploiting wind power; corresponding capacity will be 100 million KW. China develops diverse patterns of solar power; thereafter solar collection will exceed 400 million m2. It also actively exploits biomass electricity.

Promote clean fossil electricity. China emphasizes coal washing, shuts small thermal units, speeds up supercritical– and ultra-supercritical– technology, enhances thermo-cogeneration capacity as well as CO2 generation; actively develops circular economy. It expands power transmission from western to eastern; strengthens ultra–high voltage as well as smart grids. It will construct more CCS projects; thereafter, set up platform of national technology innovation.

Optimize institutional arrangement. China is to reform legal regime as well as regulations on electricity; especially separate transaction from distribution, revise pricing mechanism, and extend international cooperation. It will deepen electricity market and develop CO2 auditing, diverse mitigation approaches; meanwhile, coordinate mitigation and power generation.

High-Resolution Modeling of China's Power Sector with a Particular Focus on Advanced Nuclear Technologies

AP. Avrin (1)
(1) University of California, Berkeley, Energy and Resources Group, Berkeley, CA, United States of America

Today, China’s electric power sector accounts for 50% of the country’s total greenhouse gas emissions and 12.5% of total global emissions. The transition from the current fossil–fuel-dominated electricity supply and delivery system to a sustainable, resource–wise system will shape how the country, and to a larger extent, the world, addresses local pollution and global climate change. While coal is the dominant primary energy source today, rapid ongoing technological changes coupled with strategic national investments in transmission capacity and new nuclear, solar and wind generation demonstrate that China has the capacity to completely alter the current trajectory. For the past decades, the country’s nuclear fleet has consisted in a dozen coastal water–cooled nuclear reactors using an open fuel cycle. In addition to strong nuclear research and development programs, China’s increasing deployment of renewable energies and ambitious environmental targets towards sustainability make the extent and the nature of the role of nuclear in the power sector more unclear than ever. We present an integrated model of the Chinese electric power sector to analyze the pros and cons of all various energy transition scenarios. SWITCH, a high resolution modeling tool under development at the University of California, Berkeley, is used to analyze least–cost generation, storage, and transmission capacity expansion pathways for the electricity mix. Using the recent announcement made by President Xi Jinping to bring the country’s carbon emissions to a peak by 2030 as a framework to assess potential future profiles for the energy mix, we show that building up to 380 GW of nuclear capacity by 2030 is part of the optimal, least expensive trajectory for the power sector. While the construction of such a large fleet of reactors in about 15 years might be challenging, it proves that nuclear cannot be excluded from discussions regarding long–term planning of the electric power sector in China. Using SWITCH, we also find that a carbon price of ~$40/tCO2 would achieve the 2030 carbon peak. Such a figure has a direct impact on the level of renewables and nuclear deployment in the country and, as a consequence, on the specific reactor technologies and fuel cycle options to be developed. In particular, we investigate the role of fast–neutron reactors as part of a national plan to close the nuclear fuel cycle and present resulting pathways.
for Generation IV technology deployment, according to different trajectories for CO2 emissions reduction targets and costs evolution by 2050, and different levels of variable renewable energy integration.

P-3303-02
The System Effects and Electricity Market Impacts for Germany and the EU of the Energiewende Policy in Germany

M. Blesi (1); J. Welsch, (2); M. Wiesmeth (2)
(1) IER University Stuttgart, Stuttgart, Germany; (2) University Stuttgart, Ier, Stuttgart, Germany

This energy policy, which is even internationally referred to as the ‘Energiewende’, is based on the long-term vision of renewing the energy supply by the year 2050. In this context, a Pan-European TIMES energy system model (short: TIMES PanEU) points out the broader system effects and the impacts on the total costs of electricity supply and storage requirements which result from further deployment of renewables. TIMES PanEU contains all countries of the EU-28, plus Switzerland and Norway, and covers on country level all sectors connected to energy supply and demand like the supply of resources, the public and industrial electricity, and heat supply in the sectors industry, commercial, households and transport. The scenario analysis shows that the total system costs will be more than doubled by an increasing share of renewables. The reasons for the higher total electricity supply costs are the low capacity credits of variable renewable power plants, the increased need for capacities from dispatchable power plants and the additional costs for transport and distribution.

The model accounts for the fixed and variable cost of each electricity production mean: The fixed cost does not depend on the actual production, while the variable costs are proportional to the MW hour production. Similarly, the CO2 emissions have both a fixed (plant construction) and a variable component.

The model is used to estimate the impact of a larger share of renewable energy on the electricity mix at the French national scale and the CO2 emissions. The intermittency of PV and wind energy imposes the development of backup solutions and storage technologies. The energy storage requirement are affected by the temporal resolution. This can be more than doubled by an increasing share of renewables. New renuenergization schemes should be required for the necessary balancing and capital services. Additionally, the integration of large shares of variable renewables requires large electricity storages, power to heat, Electromobility and power to gas capacities. Thereby it is possible to map the interaction between electricity, heat and gas sector in TIMES PanEU. To this it will be examined, which temporal resolution is required for mapping different scenarios with different electricity production means of fossil and renewables.

P-3303-03
Impact on the CO2 emissions of an increasing share of renewable energy in the French electricity mix

FM. Breon (1); B. Bonin, (2); O. Boucher (3); A. Laureau, (4); E. Merle, (4); J. Miss, (5); Y. Richet, (5); H. Safa, (6); F. Thais, (7)
(1) PSL, Mines ParisTech, Center for applied mathematics, Sophia–Antipolis, France; (2) PSL, Mines ParisTech, Mathematics and Systems, Center for Applied Mathematics, Paris, France

The French electricity power mix is dominated by Nuclear as it provides about 75% of the total consumption. Hydroelectricity is the second main source of electricity production, being anti-correlated with the demand. Wind electricity is very significantly smaller in winter than in summer, which is anti-correlated with the demand. Wind electricity is very much dependent on the wind, and production variations of a factor more than 100 have been observed at the French national scale. Photovoltaic electricity is null during the night and significantly smaller in summer, which is anti-correlated with the demand. Yet, the requirement for backup power sources that are used at a fraction of their capacity has a direct impact on the overall production cost. In addition, to follow the intermittency of variable renewable energy production, it may be necessary to use CO2-emitting techniques, such as gas power plants.

We have developed a model that analyzes the electricity demand and production at the French national scale. The model accounts for the fixed and variable cost of each electricity production mean: The fixed cost does not depend on the actual production, while the variable costs are proportional to the MW hour production. Similarly, the CO2 emissions have both a fixed (plant construction) and a variable component.

The model is used to estimate the impact of a larger share of renewable energy on the electricity mix at the French national scale and the CO2 emissions. The intermittency of PV and wind energy imposes the development of backup solutions and storage technologies. Additionally, the integration of large shares of variable renewables requires large electricity storages, power to heat, Electromobility and power to gas capacities. Thereby it is possible to map the interaction between electricity, heat and gas sector in TIMES PanEU. To this it will be examined, which temporal resolution is required for mapping different scenarios with different electricity production means of fossil and renewables.

About three decades ago, the Brundtland commission released its famous report entitled ‘Our common future’. As an attempt to reconcile development and the environment, the term ‘sustainable development’ was coined for the first time, as a ‘development that meets the needs of the present without compromising the ability of future generations to meet their own needs.’ It contains, within it two key concepts: the concept of ‘needs’, in particular the essential needs of the world’s poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment’s ability to meet present and future needs.” [Brundtland, 1987]

Almost thirty years later, climate change, along with biodiversity losses, disruption of natural cycles (nitrogen, phosphorous, water), non–renewable resource depletion, and others, started to become a critical concern of our society. It seriously questions the sustainability of the intensive economic metabolism of industrialized societies. As a way out of this multifaceted crisis, many take a stand in favor of a ‘green growth’, focusing on the idea of technology-related limitations, and with the hope that technological progress will eventually enable a decoupling of energy and material throughput and environmental burdens from economic growth. Others instead put the spotlight on the conception of the ‘needs’, and advocate for a transition towards sustainable “post-growth societies”. With the Degrowth movement, the call for such a transition is consolidating into a complex, and multifaceted narrative. For the “wealthiest” countries, where the ecological footprint per capita is greater than the global sustainable level, this project may be envisioned as a voluntary, socially sustainable, equitable, smooth downsizing of production and consumption, and thus throughput, to an environmentally sustainable level, “that increases human
well-being and enhances ecological conditions at the local and global level. In the short and long-term" [Kallis and Schneider, 2008].

However, current literature still falls a bit short of providing detailed investigations of possible macro-socioeconomic and biophysical outcomes that may result from taking such paths. Several questions remain unanswered. In particular, we would like to focus here on the following issues: what concrete proposals could initiate such a transition? What could such paths induce in terms of employment, public debt, energy consumption, waste and GHG emission mitigation? What structural or institutional obstacles must be overcome and how? Etc.

Using a detailed dynamic input–output simulation model of the French monetary economy, we explore different scenarios of transition towards post-growth or sustainable societies. These scenarios seek to reflect contrasted "visions of sustainable societies and lifestyles", inferred from a survey conducted among different social groups – including in particular actors within the Degrowth movement. They involve structural and behavioral changes in consumption patterns, and integrate proposals and strategies issued from the Degrowth movement. We investigate the possible outcomes of these scenarios in terms of employment, poverty, public debt, energy consumption, waste and GHG emissions and discuss the potential strengths and weaknesses of the different visions they reflect. Our results highlight in particular the importance of cultural, social, behavioral and "non-technical" factors, and recall the critical need for the collective elaboration of a societal project.

References

P-3303-05
Integrating household behavior and heterogeneity into long-term energy planning models: The TIMES-Households framework
JM. Cayla (1)
(1) EDF R&D, Paris, France

The importance of household behavior in energy consumption is regularly raised in literature. The need to take household behavior into account and to introduce heterogeneity into economy–energy models is also generally pointed out, underlining the limitations of classic models that represent energy demand by a single mean household[1][2]. In their well-known "energy paradox" article, Jaffe & Stavins[3] single out household heterogeneity as one of the main "market barriers" to energy efficiency. Similarly, heterogeneity orients the dispersion of household behavior in terms of energy consumption and equipment purchases. Thus in order to provide useful insights to public policy debates using energy models, we should also consider this household heterogeneity as a kind of "model barrier" that could prevent modelers from correctly apprehending reality.

Nevertheless energy–economy long–term planning models still often represent energy demand by a single mean household and thus fail to capture household behavior. Indeed, many models developed using the TIMES modeling framework[4] are often technology oriented and provide a very detailed list of equipments on the supply side. Whereas the demand side generally consists in a single mean household with a unique level of demand for energy services. This lack of detail on the demand side usually leads to unrealistic results, especially in terms of technology diffusion. Indeed in these models small price increases may then lead to no impact or sudden technological change, sometimes called "bang–bang" effects.

We here describe the original modeling approach developed within the MARKAL–TIMES model framework in order to take household behavior and heterogeneity into account: the TIMES–Households model. This model depicts both household daily energy consumption and equipment purchasing behavior and focuses on the French residential and transport sectors. We show the importance of taking household heterogeneity into account in long–term planning models within the comparison of two energy price scenarios applied to two different models. Thanks to the highly disaggregated representation of households and their behavior in the model, we address the problem of unrealistic technological diffusion pathways often obtained when using an optimization bottom–up model. We also are able to address burden sharing issues which are very common and major issues related to the implementation of decarbonized sustainable pathways. Indeed our model helps quantifying the impact of energy policies such as carbon taxes, tax rebates or bonus/malus systems on household budget in terms of investment expenditures and energy bill.


P-3303-06
Opportunities and challenges for decarbonisation with electricity generation from nuclear energy
J. Cobb (1)
(1) World Nuclear Association, London, France

Generation of electricity from nuclear generation is a major global contributor to decarbonisation. Currently, nuclear generation meets around 11% of global electricity demand with very low lifecycle greenhouse gas emissions, avoiding in excess of two billion tonnes of carbon dioxide per year, compared to coal fired generation. Its high capacity factor and predictable output is advantageous compared to some low carbon electricity generation options.

Increased use of nuclear generation is a feature of a number of long–term climate change mitigation proposals. This presentation will review the projected emissions savings from nuclear generation, based third party studies and our own research. It will also review assessments of the lifecycle emissions of nuclear generation and how these compare to other generation options.

The presentation will examine the impact of different nuclear build scenarios on the nuclear fuel cycle, including global demand for uranium ore, uranium enrichment and fuel fabrication. It will identify where additional mining, processing and fabrication may be required in these separate stages of the nuclear fuel cycle.

The presentation will also examine the scope for increasing global nuclear generation. This will include options for increasing and extending generation from existing reactors. It will also include options for new reactor technology to improve performance and better utilise the uranium resource.

Given these conditions the presentation will project what the potential contribution of nuclear generation to global greenhouse gas mitigation could be and what technical, economic and political challenges there would be to realising this contribution.
The energy security implications of a low-carbon transition

E. Cox (1)
(1) University of Sussex, SPRU, Brighton, United Kingdom

In order to meet legislative targets for mitigating climate change, future energy systems will need to become secure, affordable and low-carbon – the so-called ‘trilemma’ of sustainable energy policy (Boston 2013). In Western Europe, the trilemma has received growing attention as energy security concerns rise up the political and public agenda, driven by declining indigenous fossil fuel reserves and increasing concerns over anthropogenic climate change (Kerr 2009; Winstead et al. 2007). As part of a growing body of research into energy security and low-carbon energy transitions, this paper assesses the future security of the UK electricity system in a low-carbon context. A new indicator framework for security of both supply and demand has been developed with the specific aim of making projections of the security of a low-carbon electricity system. Drawing upon recent research recommendations, the framework utilises a ‘dashboard’ approach to security analysis which is capable of identifying potential red flags for the future security of a low-carbon electricity system (Mitchell et al. 2013). The paper analyses the importance of timescales of reference when addressing energy systems, and thus focuses on assessing both short-term ‘shocks’ and long-term ‘stresses’ to the electricity system (Boston 2013; Energy and Climate Change Committee 2011). As such, the future security of the UK electricity system is assessed under four key themes: Availability (long-term), Reliability (short-term), Affordability, and Sustainability.

The security assessment framework has been applied to a set of three transition pathways, all of which aim to reduce carbon emissions from the electricity sector by 2050. The three transition pathways have been chosen to reflect the importance of the overriding governance logic and normative goals which could lead to different energy pathways. One pathway envisages deregulation and market-centrism, one envisages large-scale centralised control, and the third pathway envisages a decentralised, small-scale electricity system controlled by civil society and consumers. As such, the analysis seeks to compare the future security of some of these contrasting governance options, in an attempt to flag up areas of concern and to highlight the major trade-offs which may emerge when seeking to balance security, affordability and carbon goals in energy policy.

This presentation will introduce this new methodology for assessing the energy security of low-carbon transition pathways. Results from the empirical analysis will be presented, along with the implications of these results for the energy security of a low-carbon transition. The presentation will offer some insights of the key measures for improving low-carbon electricity security, and the key trade-offs which could emerge between the security, carbon and affordability aspects of the trilemma.


P-3303-08

An analytic framework to explore low-carbon energy pathways in Kosovo

D. Kammen (1) ; N. Kittner (2)
(1) University of California Berkeley, Energy and resources group, Berkeley, United States of America
(2) Energy and Resources Group, Berkeley, CA, United States of America

Kosovo’s power sector suffers from poor reliability and rising costs. The World Bank and other potential donors have proposed construction of a new 600 MW lignite based coal-fired power plant in 2017, despite a pledge to no longer finance coal projects for extreme and rare circumstances. Kosovo has extensive coal resources, but also hydropower, wind, solar and biomass potential. Examination of the available options and the need to act quickly on the investment portfolio for Kosovo are critical for the local population and economy. At the same time, the financing of a coal plant in Kosovo serves as a pivotal test on the international stage for future financing of coal projects worldwide, especially in China and India. We investigate alternative low-carbon energy pathways to building the lignite coal plant and find a range of scenarios that all meet Kosovo’s energy needs at lower cost than a new coal plant. We developed an analytic platform to model the electricity grid and constructed multiple scenarios for sensitivity testing. Our analytic platform looks at the cost, options, and impacts of different decarbonizing energy pathways— including a view into different energy efficiency measures, combinations of solar PV, wind, hydropower, biomass, and the introduction of natural gas. We find that a $30/ton carbon price increases costs associated with the new coal plant by at least $330 million USD (Kittner et al., under review). We find that the lignite coal plant remains the costliest option based on finances alone, even before considering the cost of carbon, health impacts, and job creation impacts. We introduce both a deterministic modeling platform to explore scenarios for Kosovo and for neighboring countries, and provide a LEAP platform version for policy makers and other interested parties to use in comparing costs, reliability, and environmental impacts of energy futures.


Decarbonizing the UK electricity sector by 2030: progress and outstanding challenges

A. Kazaglis (1) ; J. Skea (2)
(1) UK Government, Committee on Climate Change, Committee on Climate Change, London, United Kingdom
(2) Imperial College London, London, United Kingdom

The UK’s Governments’ statutory advisors on climate change – the Committee on Climate Change (CCC) – have advised that near-complete decarbonisation of the power sector by 2030 is part of the low carbon path to meeting long term emission targets. The Energy Act 2013, Parliament has now recognised the need for rapid decarbonisation of the power sector as a priority.

This talk will cover progress towards power sector decarbonisation and outstanding challenges.

Recent developments include updates in the policy framework through the Electricity Act 2013, and a step change investment in low-carbon capacity (particularly wind). The underlying emissions intensity of the UK’s electricity grid – meaning the intensity that could be achieved if the grid were to optimise emissions – has dropped by around 40% since 2007.

However, outstanding challenges include a lack of certainty beyond 2020, which is a issue for the supply chain and investment with long lead times and the CCC recommend a legislated 2030 carbon intensity target to address this. An innovation strategy is also required for promising but currently expensive technologies (e.g. offshore wind and CCS) to clarify that there will be a market for these technologies if cost reductions can be achieved.

P-3303-10

Supplying reliable renewable electric power from desert regions to meet the electricity needs of growing economies
The share of renewable energies in the mix of electricity production is increasing worldwide. The trend is driven by environmental and economic policies aiming at a reduction of greenhouse gas emissions and an improvement of energy security. It is expected to continue in the forthcoming years and decades. Electrical demand is related to weather and climate factors such as the diurnal and seasonal cycles of sunlight and wind, but is also linked to less predictable variability on longer time scales. The intermittency and the risk of medium to long-range predictability of the renewable electricity production (solar, wind power) could eventually hinder their future deployment. Intermittency is indeed a challenge as demand and supply of electricity need to be balanced at any time. This challenge can be addressed by the deployment of an overcapacity in power generation (from renewable and/or thermal sources), a large-scale energy storage system and/or improved management of the demand.

The main goal of this study is to provide a spatial optimization of an ideal renewable energy system at the French and European scales. We estimate the potential of dispatchable renewable energy sources like CSP that can be deployed at large-scale in remote regions or on land with non- or low-competing land-use for agriculture would be particularly valuable.

Desert regions are, therefore, potential suitable land for CSP expansion in terms of low competition for land use and the high levels of solar irradiation. Research shows that a dispersed and coordinated fleet of CSP plants equipped with thermal storage can supply large amounts of reliable power at reasonable costs, in some desert regions (Trieb et al., 2012). These regions, however, are far from centres of demand where power would be consumed, requiring large transmission lines to connect generation plants to the centres of demand (Trieb et al., 2012). We therefore examine the potential of a fleet of CSP plants to supply and transport reliable renewable electric power to large centres of demand, which are large cities worldwide. The desert regions in focus are located in China, India, the United States, and North Africa and the Middle East; this last region produces solar power for global and European scales. We use eCMWF (European Centre for Medium–Range Weather Forecasts) ERA–interim meteorological reanalysis and meteorological fields from the Weather Research and Forecasts (WRF) model to estimate the potential of dispatchable renewable energy sources. Electricity demand and production are provided by the French electricity network (RTE) at the scale of administrative regions for years 2012 and 2013.

Firstly, we will show how the simulated production of renewable energy compares against the measured production at the national and regional scale. Simulated renewable energies production (wind and solar) will then be clustered in order to highlight the temporal complementarity (or lack of) between different regions and energy sources.

Secondly, we will present preliminary results from an optimization procedure that aims to minimize the cost of an ideal system composed of renewable energies, thermal plants and increased storage, as a function of a hypothetical carbon emission penalty. The optimal spatial distribution of renewable wind and solar energy systems will be assessed at the French and European scales under the constraint of a balance between demand and supply.

Decarbonising China’s electricity sector: the prospect for biomass power generation

J. Li (1); J. Xie (2)

(1) Curtin University of Technology, Perth, Australia; (2) South China Agricultural University, Guangzhou, China

China is struggling to accelerate its economic development and transition to a lower carbon intensity trajectory. The decarbonisation of the electricity system plays a determining role in low carbon growth in China as it has become the largest power generator in the world and power generation contributes to nearly half of the country’s carbon dioxide emissions. More than two-thirds of existing electricity generation are coal-fired, making China’s electric power sector the most carbon intensive in the world. Total installed generating capacity would more than double over the next 20 years. To control the development of China’s power sector has tremendous implications for global carbon emissions reduction and temperature increase stabilisation. Biomass power generation offers a natural window and opportunity to address multiple challenges (economic, social and environmental) in the context of fast economic and demographic growth in large emerging economies. Bioenergy can also bring about more secure energy supply, better balance sheet, improved local labour market and social welfare through green jobs creation, poverty alleviation and greenhouse gases and air pollution mitigation. Based on lessons drawn from...
from the markedly rapid development of wind and solar power observed in the last decade, this paper attempts to shed light on the status quo, achievements, opportunities and underlying challenges of scaling up biomass–fuelled heat and power generation in China. Our analysis focuses on the achievements and prospects for China’s power sector. It then investigates the role of biomass in mitigating power generation associated GHG emissions and analyses the challenges in scaling up biomass power generation in China. Drawing lessons from the wind and solar power, the analysis will proceed to address the economic efficiency of biomass power by investigating the prospect of incorporating power sector in the emerging carbon market and achieve cost-efficient GHG emissions as mitigation. The last part offers some concluding remarks and policy implications for decarbonisation in China’s electricity sector.

P-3303-13
Asian perspectives in governing the deployment of smart grids
D. Mah (1)
(1) Asian Energy Studies Center, Hong Kong Baptist University, Hong Kong, Hong Kong

Climate change concerns, rising energy costs, and risks of nuclear power have heightened the urgency of a transition to a low-carbon future worldwide. Smart grids represent one of the most revolutionary developments in energy management by integrating advanced information technology as a way to modernize existing electricity networks. Smart grids have the potential to accelerate the deployment of more decentralised electricity supply sources (e.g. distributed generation and demand-side measures). Smart grid technologies are increasingly being tested and adopted in developing and developed economies (e.g. the U.S., the U.K., Japan, and China).

Although smart grids have become an emerging theme in the energy literature, critical understandings on how and why smart grids have been developed in the ways they have, and their implications for demand-side measures. Smart grid technologies are increasingly being tested and adopted in developing and developed economies (e.g. the U.S., the U.K., Japan, and China).

This paper aims to provide insights on the ways smart grids may evolve and enhance sustainable energy transitions in Asia. Based on preliminary results of an ongoing project, we will examine the emerging interactions between the state, utilities, business, and electricity consumers, as well as the associated implications on the developments of smart grids in China and Japan. Our analysis will focus on three policy themes: (1) the development of a new regulatory framework (for rectifying utilities’ disincentives to renewable energy and energy efficiency); (2) business model innovation (to develop business strategies to develop business strategies to renewable energy and energy efficiency); (2) business model innovation (to develop business strategies to cost-effectiveness of demand-side measures). This analysis will proceed to address the economic efficiency of biomass power by investigating the prospect of incorporating power sector in the emerging carbon market and achieve cost-efficient GHG emissions as mitigation. The last part offers some concluding remarks and policy implications for decarbonisation in China’s electricity sector.

P-3303-14
Carbon issues for power systems: a French-US cross contribution
N. Maizzi (1); D. Kammen (2)
(1) PSL, Mines ParisTech, Mathematics and Systems, Center for Applied Mathematics, Paris, France; (2) University of California Berkeley, Energy and Resources Group, Berkeley, United States of America

Spurred by the need to address climate change while promoting economic vitality and sustainability requires a new class of energy system models that facilitate a dialog between mathematical approaches to economics, public policy and strategic thinking. This approach ideally affords a platform to integrate equally technical and social perspectives on power systems, something that has proven particularly difficult in the past for a variety of data, analytic, and conceptual reasons. While models are inherently inaccurate representations of natural and social processes, we have found considerable value in comparative ‘model complements’ where different approaches are brought into dialog. To accomplish this, our two teams, based at the Ecole des Mines de Paris and at the University of California Berkeley, have synthesized this comparison and conversation. The two platforms TIMES and SWITCH respectively permit different visualizations of energy choices and scenarios. These prospective modelling tools are a hybrid of traditional models used in the 1960’s from the dialogue between mathematicians and economists and based on a concept of optimality. The way they support the scoping of policies on energy and climate is based on the following: a vision of transforming technical systems with the idea of an optimal timetable for employing technologies in decreasing order of merit. This can be sketched by the introduction of the internal cohesion of the energy system at technical level and, as a result, inertia, the technological barriers to remove, the benefits in endogenous learning and the macroeconomic costs of support policies are addressed.

This contribution aims to bring together parallel developments of a prospective landscape dedicated to the power sector, considering the entire chain from the production of the energy source to its use, and across the world. This will bring first elements to understand to what extent technological solutions can be brought as global solutions across regions and over the long term: namely the potential of smart grid solutions as demand response, flexibility options, spread of renewable energy, and what could be their limits, if some exist.

This approach is particularly relevant to go beyond opposing theses, either for instance considering that renewable energy sources should only be used when they are competitive, or setting ambitious short- and mid-term penetration targets to meet future GHG emission reductions. In this paper, we will present a framework that allows the comparison of different models developed in the US and in France, envisage the ways countries face energy and climate long-term issues.

P-3303-15
Power system prospective: From deep within the material to the power grid scale
V. Maizzauc (1); N. Maizzi (2)
(1) Schneider electric and MINES ParisTech, Center for applied Mathematics, Grenoble, France; (2) PSL, MINES ParisTech, Mathematics and Systems, Center for Applied Mathematics, Paris, France

To address the abysmal lack of efficiency of the electrical system (73% of losses, 45% of worldwide CO2 emissions!), an energy efficient description of electrical systems lying on a reversible interpretation of the Faraday’s law is presented.

As matter of fact, the free current density flowing in the whole power grid exhibits well-split scales allowing me to apply field hypothesis where the global condition of reversibility is replaced by embedded minimizations on the various scales involved by the power electrical system. Following a thermodynamic viewpoint, various scales were explored from deep within the material to the power grid scale.

At the power management level, the electromagnetic energy coupling acts to enforce synchronism – usually f = 50Hz or 60Hz – between all generation plants supplying the power grid. An X-Y lattice model is adopted to describe the interaction between the magnetic momentum carried by the rotor of the given machine and the magnetic field resulting from all the others [1]. Provided a large enough resistant electrodynamic torque – simulated with a strong enough correlated lattice or actually a suitable voltage plan –, synchronism is kept under admissible load fluctuation and the kinetic energy embedded in the whole power system acts as a global and huge inertia against frequency deviation which therefore may only occur on several periods.
Given that energy conservation results from the uniformity of time for any isolated system [2], this upper-aggregated scale provides two dynamic energy-based invariants specifically shaped for power systems and suitable to address the question of reliability, namely the kinetic- and the magnetic-energies embedded in the whole power grid. Conversely, following dynamically these energy-based invariants provides a way to perform a space-aggregation and a time-reconciliation of all the scales involved in the power management of the electromagnetic energy.

Hence, a dynamic reliability constraint on kinetic energy was endogenized in the technical optimum TIMES model. Dedicated to La Réunion island:

- The potential contribution of electrochemical storage technology to the power dynamics and the reliability has been demonstrated; and
- A high share of variable renewable plants (around 50%) has been considered without jeopardize power transmission.

References:

P-3303-16
Costs and benefits of a greener alternative for the development of Vietnam’s power sector

HA. Nguyen Trinh (1); M. Ha-Duong (1)

(1) CIREN/CNRS, Nogent sur marne, France

To explore pathways for Vietnam’s power system until 2040, two scenarios are developed in the current study: (1) a scenario based on current trends (BAU); (2) a greener alternative with more renewable energy and lower emissions (ALT). The authors estimate that the external costs of CO2, NOx, SO2 and PM10 in the power sector in Vietnam are 7–20, 1 328, 2 047 and 1 460 US$/ton, respectively. We find that the ALT scenario is more sustainable than the BAU scenario in all aspects. In the ALT scenario, the price of electricity and the domestic trade balance are less sensitive to fluctuations in the international price of coal than in the BAU scenario because imported fuel systems, fall up 39% of total generation capacity in 2040, as opposed to 60% in the current policy scenario. The total costs accumulated from 2010 to 2040 would be lower in the greener alternative: 632 billion US dollars compared with 974 billion US$. This difference arises from several factors: lower investment in new capacity (226 compared with 306 billion US$); lower local pollution costs (73 compared with 137 billion US$); lower CO2 emissions; and lower expenditures on imported fuels (57 compared with 115 billion US$). The outcomes of the ALT scenario are in accord with the targets for the power sector in the most recent Green Growth Strategy of Vietnam (GGSV).

P-3303-17
Institutional change and market conditions for low-carbon electricity transition in Vietnam

HA. Nguyen Trinh (1); Y. Rizopoulos (1)

(1) LADYSS, Paris, France

The rapid expansion of the industrialization and urbanization processes over the last two decades has dramatically increased the demand for electricity in Vietnam. The challenges of developing new resources, enhancing high-voltage transmission lines, and reducing transmission distribution losses imply an improvement of the current electricity system.

Considerations related to low carbon transition make part of this general context. Meanwhile, because of complex interwoven interests, major players as the powerful holding EVN (Electricity of Vietnam) seem more interested to pursue the development of fossil/fuel-based power plants than to favor renewable resources. As a consequence, a low carbon transition implies a fundamental transformation of the current Vietnamese electricity system. Focusing on the institutional and governance issues, such a transition needs “actions to remove the barriers” (IEA, 2012) and “high levels of social and political innovation” (Global Carbon Project, 2010). Indeed, the institutional environment of the energy sector has its roots in the ‘Đo moi’ policy (1986), but also in the systemic features of Vietnam combining centralisation and fragmentation: centralisation of political power and weight of the political elite, hierarchy and informal networking, progressive decentralisation of economic management, and weak civil society.

The paper proposes a mesoeconomic approach of the low-carbon electricity transition in Vietnam. We argue that political will is a necessary but not a sufficient condition for such a change. The transition process depends on interdependent organizational decisions that decide if the electricity sector and implies a fundamental transformation of the stakeholder’s positions and relations. In particular, it necessitates the existence of a critical mass of initiating actors perceiving the benefits of investing in renewable sources and having levers to redefine the rules of the game, modifying therefore the institutional framework and enabling the constitution of new structural interdependencies inside the electricity system. In this perspective, we proceed to the identification of key players, and point out the institutional and structural characteristics of the electricity market. Then, we propose an analytical grid to apprehend the change path by following the evolution of some focal variables. Concerning specifically wind electricity generation, wholesale market prices and subsidies to the single buyer indicate the balance of power between the major stakeholders and reflect the stages of the transition process.

Our work sheds further light on the processes that determine the transition to low carbon electricity in Vietnam but several limitations should be noted given the complex multilevel/multifactor character of the game. Indeed, in-depth knowledge of vertical (government to enterprise) and horizontal (enterprise to enterprise) bargaining process or of the way foreign stakeholders intervene and interact with local actors could usefully complete the analytical grid developed here. More, we focus on the single onshore wind power as an illustration of the conditions influencing low carbon transition. The method to monitor the change process could be further improved by integrating more detailed data on electricity selling prices, as well as incentives and counter-incentives for all renewable and fossil resources.

We propose a comprehensive analysis of the factors shaping/preventing the transition to low carbon electricity in Vietnam – especially those related to interest settlements, actors’ strategies, principles of governance and institutional framework – from a political economy perspective. Concerning specifically wind electricity generation, wholesale market price and subsidies to the single buyer indicate the balance of power between the major stakeholders and reflect the transition process. In addition, the paper provides a methodological contribution for the measure of structural/institutional change in the energy sector.

P-3303-18
Feasibility of a decentral renewable power system in Europe

S. Pfenninger (1); J. Lilliestam, (2)

(1) Imperial College London, Grantham Institute and Dept of Civil and Environmental Engineering; (2) ETH Zurich, Human–environment systems group, department of environmental systems science, Zürich, Switzerland

The global transition of the power sector towards clean and renewable technologies is well underway. The worldwide average annual growth rate for installed wind and solar photovoltaic capacity in 2000 have been about 25% and 45%, respectively, with installed capacities in 2013 reaching almost 320 GW for wind and 40 GW for solar photovoltaic. Considering with the rising importance of renewables, the idea of a more local, decentral electricity supply has gained increasing prominence and ideological support. Amongst advocates of a renewables-based electricity system, this is pitching proponents of a centralized renewables deployment (e.g.
based on large-scale desert solar power with a continental, or intercontinental, transmission system) against those who argue for decentralized generation and distribution (e.g. based on rooftop PV and small-scale wind combined with smart demand management).

The rapid deployment of both wind and PV in countries like Germany has seemingly brought this possibility of a radically different electricity system than the one we have today. There is, however, the potential that the approach currently established in Germany, with a spatial simulations based on satellite and reanalysis data and themselves for most or all hours of the year. To do so, independent "electricity islands» across the European Union (EU) to support self-sufficient areas can be and how much interconnection of renewable energy technologies across the EU is in fact needed to maintain system stability, the increased storage requirements, and the loss of returns to scale effects by having many small power plants instead of few large ones. Furthermore, there is the question of how technically feasible the current power paradigm is for heavily populated areas, such as those found in large parts of Europe and particularly large metropolitan areas like Paris or London.

Here, we examine the degree to which a completely decentralized power supply based on a combination of renewable energy technologies across the EU is in fact possible, answering the question of how small the smallest self-sufficient areas can be and how much interconnection (especially around cities) is needed in order to supply all electricity, cooling, and heating demands. We do this by simulating wind and solar power generation and analyzing the degrees of aggregation, interconnection and storage needed for the smallest–possible set of independent "electricity islands» across the EU to support themselves for most or all hours of the year. To do so, we use high-resolution wind and solar power plant simulations based on satellite and reanalysis data and validated against real sites across Europe, with a spatial resolution between 5 and 50 kilometers, and a temporal resolution of one hour. Using this input data, we apply the multi-scale energy systems modeling framework Calliope to determine optimal deployment scenarios for these electricity islands.

The results will show the spatial distribution of viable electricity islands in Europe, how different storage and demand response availabilities influence the structure of these energy islands as well as the resulting electricity costs at different levels of supply reliability.

**Energy Transition in Europe. The role of communities and city-regions – some comparisons between Britain and Germany**

L. Reynolds (1)

(1) L’Institut d’études avancées de Paris, Paris, France

How can city-region level public authorities in the UK help drive a low carbon energy transition? In addition, how might such a transformation of the energy regime also involve shifts in economic, social and political power?

When the energy transition in the UK is compared with the energiewende in Germany, one salient feature stands out: In Germany, new actors from local cooperatives to city authorities have become key players in the growing community energy strategy, which signals encouragement of the community energy model.

However, two significant recent developments may be challenging this trajectory in the UK. First, there are plans to devolve some central government powers to newly enhanced "city-regions». Secondly, a new government community energy strategy, which signals encouragement of the community energy model.

This paper explores the dual processes of city-regional devolution and energy transition in the UK. Drawing on early findings from a current EDF–IEA Paris Transitions énergétique study, it examines the potential for a new "civic energy sector” in the UK, and ongoing moves by UK city-regions around this question. Drawing on theories from transition studies, the sociology of technology and urban geography, this work analyses and addresses the contested questions of scale – between community, city and region – to explore the shifting, multiple and contested pathways to energy transition. How might community and city level players reconfigure the energy transition? What limits are placed on this process – including by incumbent actors in the energy sector and government? How can we understand the different visions of energy transition today, with their different imagined scales of transition and distributions of political, economic and electrical power? The conclusions drawn can help us to understand the key role played by communities, cities and regions in the transition to a low carbon society and energy regime.

**Techno-economic analysis of carbon mitigation options for the fossil fuel fired power plants in India**

U. Singh (1); A.B. Rao (2); N. Sharma (1)

(1) National Institute of Technology Rourkela, Department of Mechanical Engineering, Rourkela, Odisha, India; (2) Indian Institute of Technology Bombay, Centre for technology alternatives for rural areas, Mumbai, India

In response to the global climate change problem, the world community today is in search for an effective means of carbon mitigation. Coal based power plants in India with an installed capacity of over 149 GW, account for more than half of the energy production and 66% of electricity generation in the country. These plants emit approximately 665 MtCO2 annually i.e. 37.5% of the total greenhouse gas (GHG) emissions of the country. With a large number of new coal power plants (~ 500 plants with about 600 GW capacity) being proposed, the problem of GHG emissions is far from being solved.

A variety of options exist for reducing the carbon dioxide emissions from the existing coal-fired power plants in India – which are mostly sub-critical units. The most feasible approaches include in auxiliary natural gas boilers and ultra-supercritical or IGCC technology. Carbon Capture and Storage (CCS) is the process of extraction of Carbon Dioxide (CO2) from large-point industrial and energy related sources, transport to storage locations and long-term isolation from the atmosphere. It is being considered as a promising carbon mitigation technology, especially for large point sources such as coal power plants.

The main objective of this paper is to carry out a techno-economic analysis of the several carbon mitigation options for the fossil fuel based power plants in India. The following options would be considered:

1. refurbishing/ repowering of the existing sub-critical units with SC/USC/IGCC,
2. using imported coal with better combustion properties
3. using CCS to capture and reduce a substantial fraction of the emissions
4. a combination of any of the above strategies

However, CCS is accompanied by a huge economic and energy penalty. In case of post-combustion CO2 capture using solvents like amine and ammonia, part of the steam from the steam cycle is lost for solvent regeneration. Thus, the gross electric output of the plant is lowered. This issue can be addressed by using an auxiliary natural gas boiler. Thus, we can compare only one variant of the list of carbon mitigation options listed above.

While India has substantial coal reserves, natural gas reserves are quite low. However, recently there has been a great deal of interest in unconventional gases like shale gas and coalbed methane (CBM) in India. If shale gas and CBM can be used as a substitute for natural gas, this would considerably increase the availability of natural gas.
become more favorable than Natural Gas Combined Cycle (NGCC) plants may also be considered as a suitable option. In that case, NGCC can also be coupled with CCS.

Thus, a large number of carbon mitigation options will be analyzed so as to estimate the carbon mitigation potential as well as the associated cost of mitigation. The modeling of the plants would be done by using the Integrated Environmental Control Model (IECM-cs) developed at the National Institute of Standards and Technology (NIST). This modeling framework enables a comparison of performance as well as the costs associated with these various plant options on a consistent basis. Sensitivity of all these scenarios towards the key parameters such as the varying levels of fuel costs, plant capacity factor and fixed charge factor on the capital investment will also be studied so as to understand the policy implications of such interventions.

P-3303-21

The drivers of investment in cleaner energy production

E. Verdolini (1); F. Vona (2); D. Popp (3)
(1) FEEM Fondazione Eni Enrico Mattei, CCSD, Milano, Italy; (2) OFCE Sciences-Po / SKEMA Business School and SciencesPo, Nice and Menton, France; (3) Syracuse University, Syracuse, United States of America

The ability to match future economic growth with reduced pressure on the environment is inextricably linked with the development and deployment of low carbon technologies. An important sector that needs to be decarbonized to supply sustainable energy for all while reducing pressure on the environment is that of centralized electricity and heat production. Solar and wind tend to emit the least and their demand is projected to increase significantly over the next decades, especially in developing countries (IEA, 2014).

Many “clean” technologies for electricity production are already available, but their use is hindered because they are not cost-competitive with “dirty” technologies. Such price wedge is due to at least three reasons. First, some technologies are relatively immature, and lower costs will materialize only in the future. Second, the price of dirty technologies does not internalize the cost of pollution. Third, the energy sector is characterized by long-lived capital stock and significant sunk investment in existing (dirty) plants.

The academic debate regarding the decoupling of economic growth from polluting energy sources (decarbonization) is often framed assuming a clear-cut distinction between what is clean and what is dirty and the need for complete or partial substitution of dirty inputs with clean ones (Acoemoji et al. 2010). Both assumptions are very strong when referring to aggregate energy systems, and more specifically to the power sector. First, emissions reductions in electricity generation can be achieved using either renewable energy resources or improving the energy (and hence carbon) efficiency of fossil-based technologies. Second, if one sets aside nuclear due to proliferation and safety considerations, there is no carbon free technology that can nowadays fully substitute fossil-based energy. Specifically, renewable energy sources strongly depend on the natural endowment (ocean, hydro, wind), are highly intermittent and seasonal (solar, wind), do not have the generation potential to meet the current demand for energy alone (wind, geothermal) or are manufactured using rare metals whose availability cannot be guaranteed. Moreover, centralized electricity and heat production are peculiar in that the goods they produce (electricity and heat) are difficult to store in an economically viable way or to transport over great distances, and need to be used by consumers at the time they are produced (Battarchaya chpt10).

In this paper, we explore the implications of the peculiarities of the power sector and of available clean energy technologies. We focus on the degree of complementarity between clean and dirty electricity investment. We use data for 27 Organization for Economic Cooperation and Development (OECD) countries for the years 1990–2007 to show that to meet energy demand when the sun does not shine or the wind does not blow investments in renewable energy generation have been complemented with capacity investments in fossil power generation technologies. Specifically, our analysis confirms that systems that promote a high penetration of renewables require some backup generation capacity that is quick to react and most likely utilized under capacity for most of the time. Older coal power plants and base load plants are not good candidates to serve peak demand given their high capital costs, low operating costs, the inverse relation between efficiency and size and the long time needed for them to be brought on and off line. Conversely, high-efficiency (gas) combined cycle (nGCC) plants can be brought into operation relatively quickly and allow modular use since efficiency does not fall significantly with size, are installed to quickly compensate renewable intermittency (Battarchaya chpt10).

The implications emerging from our findings are manifold. First, at present there is no evidence that in the power sector technical change can be only be driven towards the clean input without important implications for the reliability of energy supply, energy access and energy security. Second, absent major breakthroughs in storage and reduced technology costs, many of these clean technologies may not be economically viable even if costs significantly fall due to need to balance demand and supply instantaneously. Lastly, the necessity to install peak load capacity which compensate intermittency is a further burden that is often not considered in the estimation of renewable energy costs.

P-3303-22

Global Energy and Climate Outlook: Road to Paris –Assessment from an energy system perspective of Low Emission Levels under World Action Integrating National Contributions

Z. Vrontis (1); A. Kitou (2); A. A. Labat, (3); M. Perry (3); B. Saveny, (2); T. Vandyck, (2)
(1) Institute for Prospective Technological Studies, Seville, Spain; (2) European Commission (DG JRC–IPTS), Institute for prospective technological studies, Seville, Spain; (3) European Commission (DG Climate Action), Brussels, Belgium

On 25 February 2015, the European Commission has set out its Communication, «The Paris Protocol – a blueprint for tackling global climate change beyond 2020» (EC’s Energy Union package). This paper presents the modelling work undertaken in the context of the abovementioned EC communication regarding the energy system related impacts of post-2020 global climate change mitigation policies. The analysis presented here mainly lies on results from the energy systems model POLES for the purposes of the EC preparation for the global climate negotiations. It explores on possible ways to stay below 2°C through processes established in the run-up to Paris COP21 by studying a combination of domestically determined mitigation targets for the period beyond 2020.

The POLES model is a global sectoral simulation model for the development of energy markets. It operates on a yearly basis up to 2050, with a very recent data update. Main exogenous factors of global economy and demographic projections for each region. POLES model provides comprehensive energy balances (demand, transformation, and supply) for the 57 countries / regions covering the world and detailed oil and gas productions for 80 countries. Energy demand in 15 sectors is driven by income and derived activity variables as well as short- and long-term energy prices.

In the POLES Baseline population and economic growth projections are based on the UN and OECD and the evolution of the energy markets, as driven by its own dynamic of production, supply and demand, is consistent with IEA projections. The projections do not consider impacts from unabated climate change. In this Baseline scenario, global emissions would increase at unsustainable levels: from 48 GtCO2e in 2010, 61 GtCO2e in 2030 to 68 GtCO2e in 2050. Along such trajectories, the world is at risk to experience a global temperature increase of +4°C, with sizeable impacts on sustainable growth and vulnerable groups in all regions. The Baseline scenario is in line with staying below 2°C, with global GHG emissions peaking in 2020 and reaching about 43 GtCO2e in 2050, still higher than in 1990 (+20%) but lower than in 1980 (-10%), and under the constraint of 1.5°C CO2e per capita (50th percentile is 2 tCO2e per capita), roughly the level of the least emitting regions in 2010.

The modelling confirms that all regions can define domestic mitigation goals in line with 2°C, based on their current policy experiences, and that the institutions and
mechanisms put in place under the Climate Convention framework can be mobilised to deliver enhanced climate and economic benefits, especially for the countries with less capabilities. A significant transformation of the energy system is required, including energy savings, decarbonising the power sector with renewables, nuclear and fuel switching and actions to cut non-CO2 emissions in agriculture, industry or waste. It is found that Carbon Capture and Storage (CCS) becomes an important mitigation option after 2030. Energy rich and Asian countries see their imports in volume and monetary value decreasing substantially, North America presents a balanced energy trade and fossil fuel energy producers have to adapt to improved energy use at global level. Nonetheless, Sub-Saharan Africa and Latin America remain net fossil fuel exporters, Gulf countries and Russian Federation remain the world’s dominant suppliers, and energy trade remains an important source of their income. The global investment patterns in power production are substantially modified by the introduction of ambitious GHG mitigation policies and by the related major changes in the energy mix towards renewable sources representing 40% of primary energy in 2050. Investments shift away from fossil fuels towards the power sector to tap capital-intensive mitigation opportunities. These investments enable to reduce other costs that would be required if abatement was not undertaken largely by the power sector but also by expenditure on fossil fuel imports and subsidies.

### 3304 - Climate change, carbon budgets and energy sector regulation

#### K-3304-01

The implications of 2°C carbon budgets for global energy systems

K. Anderson (1) ; A. Bows-Larkin (1)

(1) Tyndall Centre for Climate Change Research, University of Manchester, Manchester, United Kingdom

The IPCC’s fifth assessment reports (AR5) have been widely heralded as delivering unequivocal and stark messages to policy makers. Of particular relevance to this paper is the inclusion, for the first time in the IPCC’s history, of explicit carbon budgets for differing probabilities of meeting a range of twenty-first century temperature rises, from 1.5°C to 4°C. These carbon budgets provide a clear and quantifiable framework against which to assess technical and socio-economic policies for delivering the requisite rates and timeframes of mitigation.

With specific focus on CO2-only emissions from the energy system, this paper will revisit the framing of the mitigation challenge in accordance with the AR5 carbon budget range for a “likely” (66%), “likely as not” (50%) and “not likely” (33%) probability of maintaining the rise in global mean surface temperature below the 2°C characterisation of dangerous climate change. New estimates of the process–carbon feedback emissions from the cement industry, combined with a revised carbon budget estimate for deforestation will be used to determine what CO2-only budget remains for the energy sector.

The paper will demonstrate that even assuming an unparalleled agreement at the Paris Negotiations in December 2015 (COP 21), alongside highly ambitious policies for reducing emissions from cement and deforestation, the energy-only budget of CO2 post-2020 will be radically more challenging than implied in AR5’s post-2011 budgets. For a “likely” chance of 2°C, and assuming global emissions peak in 2020, mitigation of energy-only CO2 would need to rise rapidly to well over 10% p.a. by 2025 and be maintained at that rate until the very end of the 2°C budget by 2050. The story for a 1.5°C chance of 2°C though slightly less dramatic, is nonetheless beyond anything yet costenuenced by policy makers and only seldom referred to in the literature.

Whilst the implications of such 2°C pathways are interpreted by some as highly regressive, this paper seeks to outline a positive solutions–oriented agenda. The scale of the challenge of reducing CO2 by 2050, with a globalised world and an increasing population, demands moving beyond the reductionist disciplinary tools of the twentieth century. A systems–oriented and interdisciplinary approach designs infrastructure and develops institutions to offer resilience and facilitate iteration; a radical departure from abstract and theorised optimisation. Set within this context of unprecedented rates of mitigation and rapidly shrinking timeframes, it is this intellectually more exciting agenda, that informs the papers quantitative, technical and social–science content.

#### K-3304-02

Factoring Strategic and Sustainability considerations into energy sector policy and regulation: Insights from UK experience

M. Grubb (1) ; J. Hardy (2) ; J. Mills, (2)

(1) University College London, Institute of Sustainable Resources, London, United Kingdom; (2) Office of Gas and Electricity Markets, Sustainable energy policy, London, United Kingdom

The UK is widely seen as a pioneer of market liberalisation, and the UK regulator was initially established with a primary duty to promote competition, which was subsequently amended to a focus on protecting the interests of consumers. This paper outlines the UK development of policy and regulatory structures in support of decarbonisation, explaining the extent to which energy market structures and their regulation cannot be separated from the wider definitions of objectives and responsibilities.

Economic principles which fit one set of conditions and lead to one set of reforms may not be adequate in themselves when conditions or the balance of objectives change. Attempts to give the regulator an explicit primary duty relating to either security or the environment did not succeed. However the 2008 Energy Act ‘clarified’ its primary duty as being ‘to protect the interests of both existing and future consumers.’ In effect, this achieved the same thing; it gave the regulator an explicit duty to consider the longer-term implications of energy sector developments. The defining struggle within Ofgem was then its Project Discovery (2009), the findings of which were simultaneously lambasted from different camps as heresy, or derided as Ofgem finally “discovering the real world.”

The conclusion that the UK electricity market structure could not guarantee security and could not deliver the scale of low carbon investment required led directly to the government developing the UK Energy Market Reform bill, which radically changed the economic structure of the UK electricity system. This paper outlines the main rationales, components and sketches the inevitable new challenges which arise.

Ofgem also underwent internal changes, setting up a Division of Sustainable Development charged in part with ensuring that the concerns of future consumers are represented at the table of regulatory decisionmaking. Analysis of the issues at stake – and practical experience – led to the conclusion that attempts to aggregate the interests of present and future consumers (and potential trade-offs) through aggregate monetised costs/benefit appraisal was unworkable and potentially obscured rather than informed good decisionmaking. Following a 2-year process of research and consultation, in July 2013 Ofgem’s Board agreed a major restructuring of its Impact Assessment framework. This paper articulates this
new framework and the thinking behind it and outlines challenges in its implementation going forward.

**O-3304-01**

**National Plans for Utilization of Renewable Energy in Egypt**

EHM. Ahmed (1); MW. Libb (2); S. Tantawi (3)
(1) Lead Author, WG III, IPCC, climate change and sustainable development, Cairo, Egypt; (2) EEA, Climate change, Cairo, Egypt; (3) EEA, Cairo, Egypt

Egypt has various opportunities for applying renewable energy and energy efficiency technologies. Thus it is of importance to develop an overall national energy strategy that incorporates renewable sources and acts as an umbrella for the existing renewable energy and energy efficiency plans.

This strategy should be involved in the Egyptian development plan in all sectors, as this will help to overcome the existing barriers whether institutional, technical, financial, market, awareness and information or technological barriers.

The government, the Industrial Modernization Centre (IMC) and the Ministry of Scientific Research shall allocate funds for Research and development of RE & energy efficiency technologies. Four bodies may be responsible to establish collaborative work programs for 1) RET, RE systems component design and development, 2) Human Resources Training and development and 3) National innovation on near – commercial technologies and niches.

All sectors in Egypt should be integrated with this overall strategy for harmonization in actions, hence it became necessary to raise awareness on the vital importance of Renewable Energy (RE), Research and Development (R&D), and the need to rationalize energy use in homes, factories, and various production sites and services; to make this awareness realized as a rule for behavior and the lifestyle in Egypt.

**O-3304-02**

**Present and future complementarity of wind power production in EU-28**

F. Monforti (1); M. Gaetani (2); E. Vignati (3)
(1) Joint Research Centre, Institute for Energy and Transport, Cadrezzate, Italy; (2) Institut Pierre Simon Laplace, LATMOS, Paris, France; (3) Joint Research Centre, Institute for environment and sustainability, Ispra, Italy

The amount of wind energy injected in the European electricity transmission system is expected to increase in next decades following the energy transition triggered by Directive 2009/28/EC.

Nevertheless, both absolute amounts and time patterns of wind electricity supply are different in each European country because of non-homogeneous meteorological conditions, Europe being large enough to span several different climatic areas.

Indeed, different types of weather are often simultaneously present in different areas of the continent, and any planned pan-European electricity transmission grid aimed at dispatching electricity production throughout the continent has to face the challenge of balancing real time differently inhomogeneous resources such as the wind production is.

In this study, the long term (90 years) on-shore wind power supply for European countries is simulated with a daily time resolution, on the basis of the wind fields provided for the period 1961–2050 by 12 regional climate models involved in the ENSEMBLES model intercomparison project.

Thanks to this data base a long term view of the evolution of potential wind power deployment will be provided. In particular, the time complementarity of wind energy production from different countries will be analysed with a special attention to the implications that such a complementarity is expected to have for the needs for international electrical interconnections transporting electricity from high production areas to high demand areas.

**O-3304-03**

**Tackling Offshore Oil & Gas GHG Emissions – Brazil's Experience**

T. Bredarolli (1); C. Gilherme (1); AC. Luiz (1)
(1) IBAMA, Cgpeg, Rio de Janeiro, Brazil

There is growing evidence that human pressure is substantially raising the risks of crossing planetary thresholds, such as safe CO2 concentrations in the atmosphere. A viable future depends on mitigation and adaptation efforts in multiple fields and of special importance is the uptake of renewable energy (IPCC, 2014). Estimates for the year of 2011 account for approximately 140 billion cubic meters of natural gas being vented or flared worldwide (GGFR, 2013). Although this is a decrease of almost 10% since 2005, there is still much space for further reduction and this downward trend is in danger of being reversed by a number of factors, including increase in oil production in several countries such as Brazil (GGFR, 2013). Only a few countries have developed secondary legislation regarding flare and vent emissions, such as codes and guidelines, even though it is paramount to effectively regulate this activity (World Bank, 2004). It is also a topic that interests the private sector (CPD, 2014). This work presents the experience of a Brazilian environmental unit (CGPEG) in building such legislation and mitigating GHG emissions from offshore oil and gas exploration and production.

CGPEG is a unit of IBAMA (Brazil’s federal environmental agency) that is responsible for analyzing environmental authorization requests for seismic activities, drilling, and oil and gas production offshore. Since 2010, it has been working on climate change mitigation, limiting or requesting compensation for flare emissions - a common GHG source in offshore oil and gas projects. Flares burn gas, mainly composed of methane, that remains after: power generation on the platforms; gas injection and/or gas lift in the wells; or gas export to land facilities; chiefly through subsea pipelines. In 2013, CGPEG issued a guideline regarding procedures for mitigating GHG emissions, with detailed legislation and current requirements in the environmental authorization process. Two main conditions are normally made for high emitting activities: flaring limits (daily or for another stipulated period – such as the reckoned time necessary for oil production platform’s commissioning); or compensation, which may be direct (e.g. reforestation projects) or indirect (financial contribution to climate funds, such as the Amazônia Fund). As a result, over less than five years, estimates indicate that at least 225.552 tCO2eq emissions have been avoided and 3.024.160 tCO2eq compensated (equivalent to ~85,9x106 m³ of gas), generating over R$10 million funds for actions related to climate change. The industry has accompanied these developments, making gas and CO2 injection, closed flares and better emission planning a reality. Still there is a lot to be done towards more efficient energy practices.


**O-3304-04**

Design and Construction of Domestic Jatropha Oil Pressure Cooker

C. Shonhiwa (1)

(1) University of Zimbabwe, Mechanical Engineering, Harare, Zimbabwe

Household energy for cooking accounts for a big part of overall energy consumption in developing countries such as Zimbabwe. In Zimbabwe, 70% of total energy consumed is used for cooking purposes and in general wood is mainly used. The use of firewood is resulting in deforestation of large areas creating severe ecological and environmental problems. Smoke from incomplete combustion poses health risks to humans and the environment. The Jatropha oil which is environmentally friendly is readily available in parts of Zimbabwe and can be used for cooking instead of the use of firewood, gas or electricity which are not readily and affordable to the ordinary Zimbabwean.

**O-3304-05**

Remarks on electricity sector regulation in India

G. Pradhan, (1); GOA. Pradhan Or Mathur (2)

(1) Central Electricity Regulatory Commission, Delhi, India; (2) Department of Energy, Bureau of energy efficiency, Delhi, India

An invited introduction or presentation on the challenges of regulation major emerging developing economy with top priorities of basic regulatory reform and connection

**3305** - Energy efficiency as a core means to decarbonize demand

**ORAL PRESENTATIONS**

**K-3305-01**

Energy Policy, Greenhouse Gas Reduction, and Climate Negotiations

J. Sweeney (1)

(1) Stanford University, Precourt energy efficiency center, Stanford, United States of America

Nations have legitimate interests in the health and growth of use of energy, in their domestic and international security, and in the environment. These are summarized as the “energy policy triangle.” International agreements must respect these legitimate interests and nations are unlikely to comply with policy proposals that do not respect these interests. Nations must address both energy supply – expand low carbon energy sources – and energy consumption – reduce energy use per unit of economic activity.

There are at least seven classes of strategies to motivate energy efficiency and reductions in energy intensity: 1) Normal processes of economic innovation, 2) Information provision, 3) Nudges, 4) Stochastic rewards, 5) Financial incentives, 6) Competitions, 7) Regulation. There is no “silver bullet” for energy efficiency. This presentation will discuss these classes.

These options suggest recommended directions for international agreements. Each nation should 1) set a goal of economy-wide annual energy intensity reduction; 2) set a stronger goal of economy-wide annual carbon intensity reduction; 3) conduct/support energy efficiency and clean energy RD&D and promote open, broad communication of findings; 4) adopt some energy-efficiency behavioral incentives. Specific incentives will differ among nations, but should include among others: labeling of all major energy using equipment offered for sale; feedback of energy use to consumers; elimination of all subsidies for CO2-intensive energy; material efficiency in manufacturing (through reducing yield losses, re-use of materials and recycling of products), material efficiency in product design (less material per product), product-service efficiency (in transport through car sharing) and last but not least sustainable consumption patterns.

Against this background – as we move towards the question of how to achieve sustainable development goals – a more efficient use of energy, materials and products is without alternative in the sector and has to be addressed through appropriate global and sector specific policies.

However, implementation of existing measures is not a self-dynamic process and faces various challenges, even political trade offs. This holds true particularly for more ambitious long-term decarbonisation efforts as they might require not only improvements in existing production structures, but in addition a shift to low carbon electricity. Material efficiency in manufacturing (through reducing yield losses, re-use of materials and recycling of products), material efficiency in product design (less material per product), product-service efficiency (in transport through car sharing) and last but not least sustainable consumption patterns.

The presentation addresses the portfolio of options available, gives a brief overview of their technical and economic potentials, reflects synergies and tradeoffs that mitigation in the industry sector can have with other policy objectives. Discussion of long-term decarbonisation pathways are still in the very early stages of discussion as they might play a crucial role for solving the Gordian knot.


**K-3305-02**

Industry: The Gordian knot of decarbonisation on the demand side

M. Fischedick (1)

(1) Wuppertal Institut, Wuppertal, Germany

The industry sector lies at the heart of the many governments decisions regarding the maintenance of welfare and the creation of employment. On the other hand, the industry sector accounted for over 30% of global GHG emissions in 2010. When compared to the major energy-end use sectors (transport, buildings, AFOUL), industry is currently the largest emitter of greenhouse gas (GHG) emissions. The key energy intensive material-conversion sectors (cement, iron and steel, chemicals, pulp and paper and aluminium) dominate the energy use and emissions in industry. Most scenarios envisage a continuing rise in demand for materials, by between 45% to 60% by 2050, relative to 2010 production levels.

The transition from current patterns of industrial production to a future in which goods are produced sustainably requires a holistic view that goes beyond energy efficiency. From the perspective of climate change mitigation, opportunities can be found over the whole supply chain. Although currently sometimes difficult to quantify, there are significant potentials for reduction in emissions mainly through energy efficiency (e.g. fuel switch), material efficiency in manufacturing (through reducing yield losses, re-use of materials and recycling of products), material efficiency in product design (less material per product), product-service efficiency (in transport through car sharing) and last but not least sustainable consumption patterns.

Against this background – as we move towards the question of how to achieve sustainable development goals – a more efficient use of energy, materials and products is without alternative in the sector and has to be addressed through appropriate global and sector specific policies.

However, implementation of existing measures is not a self-dynamic process and faces various challenges, even political trade offs. This holds true particularly for more ambitious long-term decarbonisation efforts as they might require not only improvements in existing production structures, but in addition a shift to low carbon electricity. Material efficiency in manufacturing (through reducing yield losses, re-use of materials and recycling of products), material efficiency in product design (less material per product), product-service efficiency (in transport through car sharing) and last but not least sustainable consumption patterns.

The presentation addresses the portfolio of options available, gives a brief overview of their technical and economic potentials, reflects synergies and tradeoffs that mitigation in the industry sector can have with other policy objectives. Discussion of long-term decarbonisation pathways are still in the very early stages of discussion as they might play a crucial role for solving the Gordian knot.

Decarbonising demand by energy efficiency and material efficiency – why it is at the core of climate policy and how it could be achieved

S. Lechtenböhmer (1); L.G. Giraudet (2)

(1) Wuppertal Institut für Klima Umwelt Energie, Research Group Future Energy and Mobility Structures, Wuppertal, Germany; (2) Ecole des Ponts ParisTech, Centre international de recherche pour l’environnement et le développement circé, Nogent sur Marne, France

Decarbonising energy supplies is not sufficient to achieve sustainable, low carbon energy systems. A highly efficient use of energy has to be tackled much more seriously if mitigation shall lead to successful decarbonisation. Only if energy demand can be stabilised or reduced there will be a realistic chance to convert supply towards sustainable sources.

Final energy demand stabilisation needs high exploitation of potentials in all sectors by low energy buildings, highly efficient appliances and vehicles as well as mainstreaming best available technology all over industry. Basic materials production - which is responsible for a significant share of energy demand, however already operates close to physical limits of current processes in many countries. Here new processes and break through technologies will be needed to achieve significant reductions of energy use. Further, on a global scale means of more efficient use of basic materials such as material efficiency as well as recycling will be indispensable.

All these challenges do need concerted action on a more streamlined policy for significantly increasing energy efficiency as well as decarbonising basic industry.

O-3305-02

A long-term, integrated impact assessment of alternative building energy code scenerios in China

S. Yu (1); L. Clarke (1); J. Eom (2); M. Evans (1)

(1) Pacific Northwest National Laboratory (PNNL), Joint global change research institute, College Park, MD, United States of America; (2) KAIST Business School, Graduate school of green growth, Seoul, Republic of Korea

Building energy demand continues to increase globally, generating an unprecedented amount of CO2 emissions from the sector. The trend is not likely to wane anytime soon as a less developed part of the world grows at a rapid pace demanding the standards of living that its predecessors have experienced.

China is already the world’s second largest building energy user. Building energy consumption in China is expected to grow at least for the next several decades, as the country undergoes rapid income and population growth, requiring continued expansion of building floorspace and installation of energy-consuming devices. This poses substantial challenges for the Chinese government to maintain adequate supply of energy and for international society to address global climate change.

Development and implementation of building energy codes in China may be a sensible domestic strategy to fulfill building energy demand in an economically efficient way while at the same time reducing CO2 emissions. Building energy codes intend to promote energy performance of buildings by setting legal requirements on building design and their compliance provisions during construction periods to improve usually insufficient thermal properties of building envelope and may also cover heating, ventilation, and air conditioning, lighting, electrical power, renewable, and building maintenance. The Chinese government has implemented building energy codes since 1980s with the particular focus on the improvement of envelope insulation. All new urban residential and commercial buildings are currently required to comply with Chinese building energy codes in both design and construction stages.

This paper investigates the potential long-term impact of China’s building energy codes on building energy use and CO2 emissions based on a detailed building energy model nested within the Global Change Assessment Model (GCAM). In particular, the model represents the influence of building code implementation on the improvement of buildings shell efficiency and resulting energy demands. The model disaggregates Chinese buildings into 12 different building types in four climate zones. Specifically, the impact of building energy codes is captured through a building stock module that describes the expansion of building floorspace as a result of new construction and retirement at the regional level, as well as the interaction of the building stock with building energy codes in place, code compliance, and the degree of retrofits. This modeling approach allows for assessing the effect of building energy codes on building energy demand and associated CO2 emissions in a consistent manner, while at the same time capturing the effects of regional differences in socioeconomic development, code implementation, climate impact, and fuel choices.

In this study, we focused on the long-term impacts of various types of building energy codes that are being contemplated or could be implemented by the Chinese government. Four distinct but interrelated scenarios of Chinese building energy codes were taken into account to span possible futures of the building sector, to provide broader policy insights, and to guide the development of building energy codes at the regional and national level. By examining the influence of the major building energy codes by type and the stringency of the energy codes, we suggest the pathways that next generation building codes in China are advised to take.

This study draws three important conclusions. First, the implementation of building energy codes may substantially reduce overall building energy consumption in China, and thus finding reman uncharged with global climate change, modest assumptions of voluntary technological improvement, and economy-wide carbon policy. Second, the Chinese government can see significant impacts from expanding its efforts to improve building shell efficiency beyond new buildings in urban centers. In particular, promoting retrofits of poorly performing buildings and expanding building energy codes to rural areas may result in easier and more drastic energy savings. Finally, the potential impact of building energy codes will differ by region and sector. The greatest energy savings will accrue in urban residential buildings, particularly those located in cold regions.

O-3305-03

Directed Technological Change and Energy Efficiency Improvements

W. Jan (1)

(1) Fondazione Eni Enrico Mattei, Milan, Italy

This paper applies the Directed Technical Change (DTC) framework to study improvements in the efficiency of energy use. We present a theoretical model which (1) highlights the drivers of innovative activity in energy intensive sectors and technologies and (2) examines the impact of such activity on the aggregate demand for energy. We then estimate the contribution of these drivers through an empirical analysis of patents and energy data. Our findings show that information about energy expenditure, knowledge spillovers and the parameters governing the R&D process are sufficient to predict the R&D effort in energy efficiency-improving technologies. Second, we show that due to the streamlined modelling framework we adopt, the point estimates from our regression can potentially be used to calibrate any model of DTC in the context of energy consumption.

O-3305-04

Half the material for twice as long

J. Allwood (1)

(1) Pacific Northwest National Laboratory (PNNL), Joint global change research institute, College Park, MD, United States of America; (2) KAIST Business School, Graduate school of green growth, Seoul, Republic of Korea

This paper investigates the potential long-term impact of China’s building energy codes on building energy use and CO2 emissions based on a detailed building energy model nested within the Global Change Assessment Model (GCAM). In particular, the model represents the influence of building code implementation on the improvement of buildings shell efficiency and resulting energy demands. The model disaggregates Chinese buildings into 12 different building types in four climate zones. Specifically, the impact of building energy codes is captured through a building stock module that describes the expansion of building floorspace as a result of new construction and retirement at the regional level, as well as the interaction of the building stock with building energy codes in place, code compliance, and the degree of retrofits. This modeling approach allows for assessing the effect of building energy codes on building energy demand and associated CO2 emissions in a consistent manner, while at the same time capturing the effects of regional differences in socioeconomic development, code implementation, climate impact, and fuel choices.

In this study, we focused on the long-term impacts of various types of building energy codes that are being contemplated or could be implemented by the Chinese government. Four distinct but interrelated scenarios of Chinese building energy codes were taken into account to span possible futures of the building sector, to provide broader policy insights, and to guide the development of building energy codes at the regional and national level. By examining the influence of the major building energy codes by type and the stringency of the energy codes, we suggest the pathways that next generation building codes in China are advised to take.
The energy intensive industries, which produce that bulk materials that sustain all contemporary living, are the most energy efficient in the world. They have always paid dearly for energy, so regardless of climate or other environmental concerns, they have pursued efficiency motivated only by cost and have been very successful: the opportunities for future energy gains in the energy intensive industries are limited.

However, precisely because of their efficiency, the bulk materials are made very cheaply, and in particular are very cheap compared with labour costs in the supply chains which determine their use. As a result many decisions in construction and manufacturing are taken to minimise labour costs at the expense of increased material use. For example, in the UK we build commercial buildings with around twice the material required to meet the safety standards of the Eurocodes, and on average we replace buildings after just 40 years, when their structural integrity is absolutely sound. Our research is developing extensive evidence that we could live well by designing our buildings, infrastructure and goods to be made with half as much material and keeping them for twice as long. These two strategies, which would reduce demand for new bulk materials by 75% would be sufficient to achieve most industrial carbon mitigation targets, regardless of any future changes in the energy intensive industries themselves.

The talk will present our evidence about how to live well with much less new material, and present our current understanding of the costs of this change: as the supply chain is already seeking to optimise costs, it will cost more labour to use less material. Policy has not as yet addressed this point, but it may well prove to be a more effective mechanism for reducing industrial emissions than focusing solely on the emissions of material production.

The background to this talk is summarised in:

(1) Allwood, J.M., Cullen, J.M. and Milford, R.L. (2010) Options for achieving a 50% cut in industrial carbon emissions by 2050, Environmental Science and Technology, 44(6) 1888-1894. This paper sets out the evidence that there is limited future potential for energy efficiency in the energy intensive (bulk materials) industries.


The talk will report the evidence gathered since these three publications about the implementation of Material Efficiency, in business, government and with final purchasers.

**O-3305-05**

“Joint crossing of the valleys of death”
Exploring the need and options for formal collaboration between US ARPA-E and EU ETS’ NER 400 to accelerate the commercialisation of low-carbon breakthrough technologies in the energy and industrial sectors

T. Wyns (1)

(1) Institute for European Studies, VUB, Brussels, Belgium

This paper seeks to demonstrate that there exists a profound disconnect between the US ARPA-E and the EU Emissions Trading System (New Entrants Reserve 300) funding programmes for energy innovation. Both programmes seem to be addressing two different technology market gaps. The next step is to assess if and how this complementarity could be turned into a joined opportunity for the US and the EU to accelerate the commercialisation of low-carbon breakthrough technologies in the energy and (energy intensive) industrial sectors.

Achieving decarbonisation of the EU and US economies over the next decades will require an accelerated improvement and wide-scale deployment of low-carbon energy and industrial technologies. There are two important market gaps that can impede the commercialisation of promising breakthrough technologies. These gaps are known as the early stage “Technological Valley of Death” and the later-stage “Commercialisation Valley of Death”. These barriers are strongly present in the energy sector.

In 2007, the US Congress authorised the establishment of the Advanced Research Project Agency – Energy (ARPA-E). The ARPA–E, modeled on the Defence Advanced Research Projects Agency (DARPA), seeks to advance high-potential, high-impact energy technologies that are too early for private-sector investment. Since 2009, ARPA-E has funded over 360 potentially transformational energy technology projects, including projects that aim to significantly reduce energy use and greenhouse gas emissions in energy intensive industries (e.g. the non-ferrous metals and chemical sectors). However, while successfully moving technologies across the early stage valley of death to the pre-demonstration or small scale demonstration stage, the ARPA-E does lack the means to enable the commercialisation of breakthrough technologies that are emerging from its programmes.

In 2008, as part of the legislative review of the EU ETS for the period 2013–2020, a new entrants reserve containing 300 million allowances (NER 300) to be auctioned under the EU ETS New Entrants Reserve was established. The revenues generated through this reserve have the goal to finance low-carbon energy demonstration projects. The programme is conceived as a catalyst for the demonstration of carbon capture and storage (CCS) and innovative renewable energy (RES) technologies on a commercial scale within the European Union. Hence, the EU ETS NER is tackling the second “commercialisation” stage of the technology valley of death. Since October 2014, the European Union’s head of state and government agreed to continue this NER after 2020 and to expand it to 400 million allowances and to energy intensive industrial sectors. Successful implementation of the EU’s NER 400 will depend on the availability of promising energy and industrial low-carbon breakthrough technologies at pre-demonstration stage. This is relevant since there appears to be a first stage technology market gap in the EU or at least a gap in the development of first stage low-carbon breakthrough technologies in the EU compared to US based developments and in particular the ARPA-E programmes.

These «commercialisation» and «early stage» technology market gaps, identified respectively under the ARPA-E and the EU’s NER 300, can become a policy opportunity if both programmes start working together. Technologies emerging from ARPA-E could make use of the NER programme to enable full-scale commercialisation (vice versa, the EU’s NER could secure a broader (and maybe lower risk) project pipeline from promising low-carbon breakthrough technologies fostered under the ARPA-E. A bilateral «technology» agreement between the US government and the EU’s institutions could be considered. Such agreement will need to address some specific issues, such as the use and sharing of intellectual property rights and the introduction of a waiver under the ARPA-E’s US manufacturing requirement. The latter element is crucial since ARPA-E requires inventions developed under ARPA-E funding agreements to be substantially manufactured in the United States.


**O-3305-06**

Challenges for decarbonising basic industry: Sustainable transition of industries under competition

M. Ahman (1) ; LJ. Nilsson (2) ; S. Lechtenböhmer (3)
ABSTRACT BOOK

policies (e.g. European Emission Trading System, levy for technologies). Therefore, we focus on the impact of current individual firms whether or not to implement these drivers and barriers on the decision-making process (BOFGr) and pulverised coal injection (PCI)). We derive the (EET) from their introduction until today (top-pressure iron and steel industry). First, we analyse the diffusion of innovation behaviour of individual firms in the German We analyse the diffusion factors which give explanations for innovation. However, we also highlight the long-term need for more radical shifts in energy carriers and feedstock changes that an ambitious climate policy will induce.

The energy-intensive production of basic materials are also traded on a global market and the production is highly exposed to increasing energy and carbon costs. In the same time, the global framework for climate policy suggest that a level playing field in terms of a global carbon price cannot be expected short to medium term, if ever. This fact limits the possibilities for policy makers to effectively address industrial emissions with a “price-only” approach. The demand for basic materials are set to increase substantially with increasing material standards across the world. Recycling and material efficiency can reduce the demand growth for virgin materials. The circulation in the economy of recycled materials with foster some efficiency gains and change the energy carriers (towards electricity). However the production of basic materials from recycled feedstock will still be considered an energy-intensive industry.

The energy-intensive industry is also unique in that investment cycles are very long, usually spanning over 20 to 40 years. However, there is a need to seize these opportunities in core process steps. The 2 C target and the year 2050 is thus only 1 to 2 major investment decisions away. Thus, in order to make more substantial changes to process design, a long-term strategy is needed.

In order to manage a smooth and both socially and politically acceptable transition for both industrialized, transitional and developing countries, we suggest that focusing on material- and energy efficiency as a win-win option. Efficiency has the potential to boost competitiveness and overall economic performances if implemented properly and should thus be at the center of a global strategy. However, efficiency has to be complemented with a technology strategy focusing on more radical transformation that require innovation efforts and eventually new investment decisions in basic process designs such as electrowinning, bio or electro-plastics, CCS in industry etc.

3305—POSTER PRESENTATIONS

P-3305-01

Future pathways to a low carbon steel industry - The case of Germany till 2035

M. Arens (1); E. Worrell, (2); W. Eichhammer (3)

(1) Fraunhofer Institute for Systems and Innovation Research ISI, Energy Technology and Energy Systems, Karlsruhe, Germany; (2) Copernicus Institute of Sustainable Development, University of Utrecht, Netherlands; (3) Fraunhofer Institute for Systems and Innovation Research ISI, Energy policy and energy markets, Karlsruhe, Germany

We analyse the diffusion factors which give explanations for innovation behaviour of individual firms in the German iron and steel industry. First, we analyse the diffusion of three energy- and carbon footprint (EET) from their introduction until today (top-pressure recovery turbine (TRT), basic oxygen furnace gas recovery (BOFGR) and pulverised coal injection (PCI)). We derive the uptake of these technologies both at the national level and of individual firms. Second, we analyse the impact of drivers and barriers on the decision making process of individual firms whether or not to implement these technologies. Therefore we focus on the impact of current policies (e.g. European Emission Trading System, levy for renewable energy, European Emission Directive). We give a short insight into site specific factors which shape the economics of the selected EETs. Our analysis ends with summary and conclusions.

P-3305-02

The role of the Construction Sector in decreasing global energy needs

L. Bourdeau (1)

(1) ECTF—E2BA, Brussels, Belgium

A key European employer and contributor to quality of life and a major energy consumer and CO2 provider

Worth at least EUR 1.2 trillion of yearly turnover (2011), the European construction sector, including its extended value chain (e.g. material and equipment manufacturers, construction and service companies), is the largest European single activity (9.6 % GDP) and biggest industrial employer (14.6 million direct operatives, 30.7 % of industrial employment, 43.8 million indirect workers). The built environment affects the quality of life and work of all EU—citizens.

Buildings use 40 % of total EU energy consumption and generate 36 % of greenhouse gases in Europe. The construction sector is at the critical path in decarbonising the European economy by 2050, reducing its CO2 emissions by at least 80 % and its energy consumption by as much as 50 %. As the replacement rate of the existing stock is very small (1–2 % per year), acceleration is urgently needed.

Strategic and general objectives

The vision of the construction sector is to drive the creation of a high-tech building industry which turns energy efficiency into a sustainable business. Connecting construction industry to other built environment system supporters and stakeholders (e.g. building owners) will be the decisive step to reach economic, social and environmental goals. By creating and fostering a research driven paradigm shift, the construction industry would become competitive on a global level in the design, construction and operation of the built environment while sustaining local economies through job creation and skills enhancement, driven by the vast majority of SMEs active in the value chain. In this framework, the strategic objectives of the sector are to:

- Develop technologies and solutions enabling to speed up the reduction in energy use and GHG emission, e.g. through a higher renovation rate of the building stock at lower cost and to meet regulatory needs;
- Develop energy efficiency solutions in order to turn the building industry into a knowledge-driven sustainable business, with higher productivity and higher skilled employees;
- Develop innovative and smart systemic approaches for green buildings and districts.

This would ultimately create a solid foundation for continuous innovation in the building sector through sustainable partnerships, fostering an innovation ecosystem across value chains, which is not project based with episodic innovation activities as current practices.

The Public-Private Partnership on Energy Efficient Buildings (PPP EeB)

The Energy-eficient Buildings (EeB) Public Private Partnership (PPP) is a joint initiative of the European Commission (EC) and the Energy Efficient Buildings Association (E2BA). This initiative aims to promote research on new methods and technologies to reduce the energy footprint and CO2 emissions related to new and retrofitted buildings across Europe. The EeB PPP was set up through a higher renovation rate of the building stock at lower cost and to meet regulatory needs;

- Develop energy efficiency solutions in order to turn the building industry into a knowledge-driven sustainable business, with higher productivity and higher skilled employees;

The public sector will be involved through Public-Private Partnerships (PPP)

The Energy-efficient Buildings (EeB) Public Private Partnership (PPP) is a joint initiative of the European Commission (EC) and the Energy Efficient Buildings Association (E2BA). This initiative aims to promote research on new methods and technologies to reduce the energy footprint and CO2 emissions related to new and retrofitted buildings across Europe. The EeB PPP was set up through a higher renovation rate of the building stock at lower cost and to meet regulatory needs.
and communication technologies and retrofitting and modernisation methodologies in order to achieve energy-efficient buildings. The projects demonstrate scientific and technological excellence across all levels from early stage conception through to demonstration of the potential for commercialisation.

110 projects have been funded so far through the EeB PPP under the 7th Framework Programme (FP7) for 2010, 2011, 2012 and 2013.

P-3305-03
Determination of Optimum Imbibition for the Milling Process in Sugar Factories with Consideration of Trade-offs among Sugar Extraction, Power Production, and Water Use
S. Chantasiriwan (1)
(1) Thammasat University, Mechanical Engineering, Pathum Thani, Thailand

Manufacturing of raw sugar from sugar canes requires many processes. From energy viewpoint, three important processes are milling, steam generation, and evaporation (which includes crystallization). Milling is the process in which juice is extracted from shredded sugar cane. The outputs of the milling unit are sugar juice and bagasse. Juice is sent to the evaporation process, in which, eventually, water is separated from raw sugar. Bagasse is used as the fuel in the steam generation system, which produces steam needed to evaporate juice in the evaporation process. Since the amount of bagasse required for producing process steam is much smaller than the amount of bagasse produced from the milling process, most sugar factories install high-pressure boilers so that high-pressure steam can be used to produce power in either back-pressure or extraction-condensing turbines.

Low-pressure steam from turbines is then used in the process. Electrical power obtained from the cogeneration system usually exceeds the demand for internal use in the factory. The excess power is, therefore, exported to the national grid.

In order to increase juice extraction in the milling process, imbibition water is added to the milling unit. More imbibition water results in more thermal energy required to evaporate diluted sugar juice in the evaporation process. Furthermore, it results in bagasse with more moisture. Combustion of wet bagasse leads to not only less production of power because some of the thermal energy from combustion is required to evaporate the moisture in bagasse but also more water loss because evaporated moisture contributes to the exhaust gas to the environment with flue gas. Most sugar factories focus only on sugar extraction when selecting the amount of imbibition. Previous investigations have pointed out that the amount of imbibition should be reduced in order to attain the optimum mix of sugar production and power production. In fact, in terms of profit generation, imbibition should be less as the ratio of the profit from sugar production to the profit from power generation decreases.

In the current study, conservation of water is also considered, along with production of sugar and power. The direct effect of imbibition water is apparent. It also affects water indirectly through the amount of water required to grow sugar canes. Conservation of water has rarely been taken into account by sugar factories. However, as climate change causes scarcity of fresh water in certain part of the world, sugar factories located there will eventually find it necessary to attach economic value to water, and the results of the current study will be of benefit to them. The main objective of this study is to determine the amount of imbibition that will yield the optimum mix of sugar production, power generation, and water use. To reach this objective, mathematical models of milling, steam generation, evaporation, and power generation units are developed, along with interactions between them through mass and energy balances. Results of simulation and sensitivity analyses that show variations of optimum imbibition with important parameters.

P-3305-04
The role of energy efficiency in meeting UK carbon targets
U. Collier (1)
(1) Committee on Climate Change, London, United Kingdom

The United Kingdom was the first country to legislate ambitious climate change targets through its 2008 Climate Change Act. The Committee on Climate Change was set up to advise on the level of the carbon targets and on specific opportunities to achieve them.

This presentation will examine the role of energy efficiency in the Committee’s carbon budget advice, focusing on the energy generation sector. Buildings account for 37% of UK greenhouse gas emissions and with an ageing building stock, there is much scope for efficiency improvement. Furthermore, improving buildings energy efficiency has various co-benefits, including the alleviation of fuel poverty. This is of particular importance as the decarbonisation policies are expected to raise energy prices. Energy efficiency therefore plays a crucial role in keeping bills affordable.

The presentation will cover both analytical and policy issues. On the analytical side, we will discuss how the Committee estimates abatement potential from energy efficiency, what data limitations we have encountered and what work is underway to overcome them. We will also present our estimates of the impact of decarbonisation policies on energy and fuel costs and the scope for energy efficiency to offset these.

On the policy side, we will look at the UK Government’s current energy efficiency policy for buildings and assess what further action is needed to meet carbon budgets. We will highlight the importance of a holistic approach to energy efficiency and heat decarbonisation.

P-3305-05
Energy Sufficiency in Rural Areas - The example of French TPES
M. Dreyfus (1)
(1) CNRS – CERAPS, lille, France

Scholars and policy-makers have now widely acknowledged the key role of local governments and local initiatives in tackling climate change. In fact, for a long time climate change was seen as a global issue, ignoring the fact that its impacts are actually experienced at the local level. Yet thanks to the activities of audacious and resourceful cities as well as to the establishment of powerful transnational networks, the activities of local governments slowly got the attention of policy-makers and researchers.

In governance studies, several theoretical frameworks can be used to discuss the activities undertaken by local governments. The oldest is led by Prof. Ostrom who developed with her colleagues, the concept of polycentric governance systems. The idea is that solutions lie at the local level in the interactions of a multitude of stakeholders, public and private. Multi-level governance theories (Jordan et al. 2012; Schreurs 2008; Corfee-Morlot et al. 2009; Schroeder and Bulkeley 2009) focus on local governments and cities as important players in the provision of services and infrastructures. Authors highlight the importance of the cooperation of these local authorities through transnational networks.

A common question addressed by these various theories is the relevant scale of action to address climate change. A lot of studies now report cities initiatives, a relevant field of studies because of their important contribution to greenhouse gases (GHG) emissions. Yet smaller local governments and rural authorities are also taking action. The aim of this presentation is precisely to explore what is being done in rural territories to address the challenge of climate change.

This presentation therefore introduces TEPOS (“Positive Energy Territories” or in French “Territoires à énergie positive”). These are rural areas, “territories”, which intend to achieve energy sufficiency. The “territory” can refer to a single commune, a group of communes or a higher level of local governments’ associations such as “pays” or national
The main goal of TEPOS is to increase energy efficiency and to cover the entire local demand through renewable, locally produced, energy. They have a systemic approach considering environmental benefits along with social and economic ones. The purpose is to start a transition towards less fossil-fuel energy use, involving all the stakeholders present on the territory (citizens, companies and businesses, but also representatives of national and other public authorities). Excess in energy production may be delivered to other units, in particular urban areas, creating an interesting rural–urban partnership.

A network of TEPOS allows awareness-raising and sharing experiences between TEPOS and other local stakeholders. TEPOS are also part of a European network called 100% RES communities.

Many lessons can be drawn from this innovative experiment. On the basis of cases examples, I will address the following questions:

- What are the drivers of the TEPOS projects?
- What concrete measures are taken to mitigate GHG emissions?
- What concrete measures are taken to adapt to climate change?
- What legal tools (in particular what kind of companies: public ownership, semi-public, private or citizen’s ownerships) are used?
- How rural and urban authorities cooperate?
- How influential is the participation to a peer network?

Answers to these questions will hopefully help identifying good practices, inspiring for other stakeholders in different contexts.

**P-3305-06**

**Impacts of Energy Efficiency Improvements in Transportation Sector on Future Emissions and Air Quality in Thailand**

S. Carivait (1); P. Cheewaphongphan (1); A. Janpen (1); TBT. Pham (1); T. Boonman (1); S. Chatani, (2)

Evangelical Academies in Asia, Thailand; (2) National Institute for Environmental Studies, Tsukuba, Japan

As other developing countries in Asia, Thailand is accomplishing rapid economic growth during the last decades. The expanding economic activities have resulted in a significant increase of energy consumption and carbon dioxide (CO2) emissions as well as heavy air pollution. Transportation, especially related to on-road, has been recognized as the top energy consuming sector since the beginning of 1990s. Also, it has been forecasted that energy efficiency improvements in this sector would contribute to the highest energy saving, up to more than 16,000 ktoe in 2030, and consequently to a significant national petroleum oil import reduction.

In this study, we evaluate the impacts of current and possible future on-road transport emissions on air quality in Thailand. The data for 2050 is used to project future transport emissions in 2030. To this end, we first developed the Thailand’s emission inventory of both in urban and rural areas in the country. to this end, we first developed the Thailand’s emission inventory of all sources using the Greenhouse Gas and Air Pollution Interactions and Synergies (GAINS)-Model. We develop two possible scenarios of future emissions, a scenario where only renewable energy is used. In this scenario, primary electricity is produced only from renewable sources. Some of this electricity can be used directly; storage capacities are however needed to buffer surplus energy so that it can be used during time periods with less RE availability. This temporary energy storage always implies losses, especially if it needs to bridge long-term energy compensations, e.g. seasonal effects from surplus RE supply during summer to cover RE shortfall during winter. Depending on the type of energy application as well as on the locally available RE resources, the amount of required storage varies, and thus the associated losses. Based on these interrelationships, new weighting factors are being introduced: the so-called PER factors (Primary Energy Renewable). The PER factor for domestic electricity use, for example, is comparatively low because the demand is fairly constant throughout the year and thus the share of electricity that can be used without

We will evaluate the model 2010 results with observations obtained from the 64 air quality monitoring stations operated by the Pollution Control Department (PCD), Ministry of Natural Resources and Environment (MOnRE), Thailand. The emissions of carbon dioxide (CO2), carbon monoxide (CO), nitrogen oxides (NOx), non-methane volatile organic compounds (NMVOCs), primary particulate matter with diameters lesser than 10 microns and 2.5 microns (PM10 and PM2.5), and their components including black carbon (BC) and organic carbon (OC) in 2010 will be analyzed versus those found for BAU and EEDP in 2020, 2030 and 2050. The emission reductions from BAU to EEDP scenarios will be described and discussed to assess the effectiveness of energy efficiency improvements in place. Changes in O3 and PM from 2010 to 2050 will be presented and discussed to evaluate the impacts of future emissions on the air quality improvement.

**P-3305-07**

**Sustainable building: Passive House combined with renewable energy**

J. Grove-Smith (1); F. Wolfgang (2); B. Krick, (1)

(1) Passive House Institute, Darmstadt, Germany; (2) University of Innsbruck, Institute for structural engineering and material sciences, Innsbruck, Austria

This contribution will highlight the importance of energy efficiency as most important measure to address the impact of buildings on climate change. It further explores the correlations between energy efficiency and renewable energy in the context of sustainable use of available resources. Specific project examples and regional approaches will be presented to illustrate the potential impacts, e.g. experiences from the EU-wide project PassREG supported by Intelligent Energy Europe.

Over a third of the total energy consumed in developed countries is required for operating buildings, especially to heat them. This consumption can be reduced by up to 90 % using Passive House technology, and the remaining demand can be met sustainably using renewable energy. The Passive House Standard (PH) has proven itself as a reliable building standard with significant energy savings in a range of climates with more than 50 000 units built worldwide. Hence, the Passive House Standard is not just an attractive solution for space heating; the energy transition, combined with renewable energies it is also a blueprint for the Nearly Zero–Energy Building (NZEB) stipulated in the European Buildings Directive, which will come into effect in 2021.

In order to provide reliable guidance for the combination of energy efficiency and renewable energy (RE), new assessment categories are being introduced by the Passive House Institute:

- **PH Classic**: The established Passive House Standard
- **PH Plus**: Increased level of overall energy efficiency and some RE production
- **PH Premium**: Very high level of overall energy efficiency and significant amounts RE production

The approach for the assessment of PH classes specifically does not promote the simple annual offset of on-site energy demand and energy production in context only of the individual project. Direct offsetting disregards important aspects such as energy loss due to storage and space availability (RE production). The Passive House assessment is thus based on a contextualised methodology, which anticipates the energy transition and considers the energy mix in a building in terms of the available RE only renewable energy is used. In this scenario, primary electricity is produced only from renewable sources. Some of this electricity can be used directly; storage capacities are however needed to buffer surplus energy so that it can be used during time periods with less RE availability. This temporary energy storage always implies losses, especially if it needs to bridge long-term energy compensations, e.g. seasonal effects from surplus RE supply during summer to cover RE shortfall during winter. Depending on the type of energy application as well as on the locally available RE resources, the amount of required storage varies, and thus the associated losses. Based on these interrelationships, new weighting factors are being introduced: the so-called PER factors (Primary Energy Renewable). The PER factor for domestic electricity use, for example, is comparatively low because the demand is fairly constant throughout the year and thus the share of electricity that can be used without
ABSTRACT

The assessment approach emphasises the importance of efficiency when it comes to heating energy, which is what the Passive House Standard stands for. Efficiency in this sector has the highest potential for further energy consumption reduction. As renewable energy sources are more efficiently used, more energy can be produced and used responsibly and thus mitigating the impact of buildings on climate change.

P-3305-08
Integration Assessment of China's Energy Efficiency: Index Decomposition and Frontier Approach Applications
J. Jiang (1); Z. Tao, (1); R. Sheng, (1)
(1) Institute of Quantitative and Technical Economics, CASS, Beijing, China

Policies for improving energy efficiency are one of the most effective ways to solve the contradiction between supply and demand of energy and to relieve environmental pressures for the Chinese Government. Because of several indicators to measure energy efficiency, resulting in different definitions of policy efficiency implementation. First, this paper compares the energy efficiency measures from the supply side and demand side of energy, that is, a single element of energy efficiency and energy efficiency based on total factor productivity (TFP) estimates. In order to study the effects of energy efficiency change and its driving factors, the paper adopts index decomposition models and frontier approach, the former implies that production efficiency, and the latter provides a variety of frontier estimation methods, including non-parametric estimation of data envelopment analysis (DEA) and parameter estimation of stochastic frontier analysis (SFA). Based on available statistical data, the paper applies Divisia index decomposition to two different definition of energy intensity, e.g. final energy consumption per unit value added of industries, per capita residential energy consumption; then, using DEA of the total factor productivity estimates across-sector energy efficiency and empirical research on the driving factors of energy efficiency. Finally, based on model results, it presented energy efficiency policy implications at macro and industry level.

Taking into account the final energy consumption does not include the intermediate conversion process energy consumption, compared to the total energy consumption, this paper argues that final energy consumption can be used to more accurately reflect the energy efficiency of various industries, defines industrial energy intensity as ration to final energy consumption to industrial value added. Since only 6 industries have detailed statistical data on energy consumption by fuel type, this article analyzes only 6 indices of energy efficiency for residential energy, the average residential energy consumption defined as household energy efficiency. Energy balance tables of 1996–2012 in China energy Statistical Yearbook and other data, 6 industry and residential energy efficiency used Divisia index AMDI model decomposing, results showed that economic policy and energy policy factors in different periods of energy efficiency change play different contribution rates. In terms of per capita residential energy, economic development and the improvement of building energy efficiency play a major role.

Total factor energy efficiency, that evaluates energy efficiency during economic production process, is considered as the production efficiency element of inputs paid with labor, and capital together, while also considered «bad» outputs, such as CO2, wastewater, that is, model development is under environment regulation of constraint. The paper uses directional distance function of DEA method to estimate industrial energy efficiency, and empirical analysis on effects factors of energy efficiency. Preliminary results show that overall China's energy efficiency tends to decline, but with the implementation of energy-efficiency policies in recent years, beginning in 2007 on energy efficiency has gone up. From the perspective of industry, increased industrial energy efficiency is quite obvious, while transportation, agriculture showed a downward trend. Analysis the economic development and foreign direct investment (FDI)

of influencing factors shows a significant positive impact on total factor energy efficiency, while endowment structure has a negative effect, reflecting the disadvantages of excessive capital input. Industrial structure, energy prices and environmental regulation have the negative effects on energy efficiency, due to the globalisation of economic development in China, as well as the energy market is not perfect, this section needs further in-depth analysis.

Acknowledges: This paper was based on work supported by National Basic Research Program of China under Grant No.2011CB955801, and Scholar Program of Innovation Project in Chinese Academy of Social Sciences (2014–2018).

P-3305-09
How to achieve climate stability in cultural heritage buildings despite climate changes
J. Käferhaus (1)
(1) Kaferhaus GmbH, Vienna, Austria

In future we cannot afford any longer our energy bills especially in museums, castles and other historic buildings with need in climate stability especially under negative auspicious of climate change, which means warmer outdoor climate in future.

So far our one-dimensional thinking in 'repairing' wrong development by big machinery is no longer a suitable method because of lack of maintenance, energy efficiency of energy-saving parts of energy budgets for cultural heritage.

As past has shown very old and unique artifacts in historic buildings have overcome very long periods of about 500 to 900 years – also with very warm periods – without any technical support or cooling units what so ever. The exceptional ‘Altar of Verdun’, a masterpiece of enamel work of 1188 in Stift Klosterneuburg, close to Vienna, as well as the unique collection of all kinds of artifacts of Carl Gustav Wrangel in the Swedish Castle of Skokloster and Ambros Castl in Innsbruck, with its famous collection gallery, are best examples how big building masses keep valuable masterpieces in constant climate conditions in the sense of preventive conservation.

Big masses of historic buildings mostly give best shelter against summer heat. Hot summer outside temperatures mostly will be compensated by colder nights and the buffering capacity of huge walls. Often summer night cooling through natural ventilation will improve this sustainable effect.

In order to reach moderate summer indoor temperatures natural ventilation as well as possible outside shading in accordance with monument authority’s prescriptions will reduce indoor heat achieving acceptable indoor conditions when indoor loads also will be reduced accordingly.

Also winter heating in historic buildings could be reduced similar to low energy consumption buildings with pure radiation heat by warming up building masses. With pure radiation heat energy bills in historic buildings could be cut to half. Also with warm shell negative consequences of rising damp, mould or condensation on cold walls could be avoided as the following famous examples proof vividly.

Einsiedeln Monastery with an underground store room for precious, historic books and an old library, heated by waste heat of electronic data processing.

Museum of Fine Arts, Vienna, showroom IV, got rid of mould heat and cut energy bill by half.

Academy of Fine Arts, Vienna, and store room in the basement, heated by pure radiation heat got best indoor climate stability.

Church in Gerling in the country of Salzburg got a pure, damage preventive heating with solar support

Chapel in Schönbrunn Castle, Vienna, during EU project ‘SMooHS’ got simple wall heating, dry walls and indoor climate stability with only small winter heating.

Keywords: sustainability, energy-saving, indoor climate stability, museums climate, preventive conservation.
P-3305-10

Promoting Renewable Energy in India for Sustainable Agriculture: Issues and Challenges

N. Kaur (1) ; R. Kaur (2)

(1) Panjab University, Public Administration Department, Chandigarh, India; (2) Panjab University, Public Administration Department, Mohali, Punjab, India

Agriculture and its allied sectors constitute as the largest livelihood provider to and also contributes to 18 per cent of GDP. India accounts for 17% of the world population but has only 4% share in energy consumption and within this very less share of renewable energy usage. Indian agriculture is critical and it contributes to 40% of global greenhouse gas emissions. Therefore, it is necessitates that different policies and programmes at Union level and State level like National Mission on Energy Efficiency, Biomass Energy for Rural India, Solar and Wind Energy Projects. India has also set a target of generating 175 GW of renewable energy by 2022. This includes 100 GW of solar, 40 GW of wind, and 35 GW of biomass. These initiatives contribute to the implementation of renewable energy resources and works with collaboration with State Governments and other allied departments.

The finding clearly reflects that innovations for use of renewable energy must be promoted through community based financial organizations (CBFOs), co-operative societies and in order to make access to these programmes available. Well organized programmes must be organized at village level in order to increase awareness and access of the farmers. Building communication between people can only help in dissemination of techniques for using wind and solar energy for energy generation.

Strategical interventions by the state through policies and programmes for use of renewable energy and active participation of farmers in implementation will pave the way towards the sustainable agriculture by using renewable resources of energy generation.

P-3305-11

Toward a Development and Co-Benefits Focused INDC for India

R. Khosla (1) ; N. Dubash (1) ; KR. Sharma (1) ; N. Rao (2)

(1) Centre for Policy Research, New Delhi, India; (2) IIASA, Energy, Laxenburg, Austria

India’s response to global climate change is rooted in meeting the country’s development needs, and aspires to be consistent with its sustainable development objectives. This is articulated as a co-benefits approach in the Intergovernmental Panel on Climate Change and in India’s National Action Plan on Climate Change. The approach emphasizes measures which promote development objectives such as the ability to provide sufficient energy, ensure access to quality energy for all, address energy security and local environmental concerns such as air pollution, land and water use, while also yielding co-benefits for addressing climate change effectively. In light of this context, our paper examines recent projections for India’s possible energy and climate futures by synthesizing and comparing the outcomes of seven policy salient modeling studies from India. The analysis illustrates the limited extent to which the available studies inform an assessment of co-benefits, that an INDC should also include a comprehensive assessment of co-benefits and emissions approach. It also identifies the basis for focusing on key areas of mitigation potential and those of uncertainty that require further analysis. The range of projections is assessed, including the reasons for the range. Based on an assessment of recent energy studies, the second part of the paper develops a methodology to overcome the existing limitations of the studies with respect to characterizing co-benefits. We delve into a single sector and use the case of energy efficiency in India’s buildings, which has amongst the highest mitigation potentials, to showcase an approach to operationalizing co-benefits. A current critical issue is the absence of mechanisms and policies that ensure access to quality energy for all, address energy security and local environmental concerns such as air pollution, land and water use, while also yielding co-benefits for addressing climate change effectively.

P-3305-12

ICT is part of climate change! Can we reduce its impact and apply good practices and tools to others society domains?

L. Lefevre (1) ; F. Berthoud (2) ; C. Gossart (3)

(1) Inria, Lyon, France; (2) CNRS, Lpmmc, univ5943, cnrs/ujf, Grenoble, France; (3) Institut Mines–Télécom, Evry, France

Information Communication and Technology comprises a lot of research initiatives (academic and industrial) are currently focused on energy efficiency during usage phase. This talk will explore technological issues of an eco-friendly life cycle approach applied to ICT systems. It will be followed and present a complete life cycle approach applied to ICT systems.

- Most of numerical models do not take into account greenhouse gases production during design and transport phase. This talk will explore technological issues of an eco-friendly life cycle approach applied to ICT systems. The usage of rare metals and their impact on planet level must be taken into account. Potential impact for extended product life and repairing possibilities will be discussed. A focus will be provided on the potential impact for extended product life and repairing possibilities. The amount of dispersed CO2 is considered in near equivalent datacenters, networks and myriads of fixed and mobile terminal equipments. The power world consumption of ICT was around 112 GWatts in 2013 (divided between in near equivalent datacenters, networks and end-users equipments). The amount of dispersed CO2 is considered as equivalent to the aviation industry. This pollution and associated energy consumption is constantly and rapidly growing. As any other industrial technology and product, ICT equipments face a complex lifecycle from the design (with rare metals), transport, to the usage and (possible) recycling. This worldwide lifecycle is responsible to consequent greenhouses gases production.

This oral contribution will follow and present a complete life cycle approach applied to ICT systems.

- A lot of research initiatives (academic and industrial) are currently focused on energy efficiency during usage phase. This talk will review the most relevant ones and present their potential of impact at large scale. We will review...
the challenges in energy monitoring of large distributed computing systems (from clouds to networks supporting BigData scenarios) and proposed associated metrics, code of conducts and best practices examples. Some rebound effects will be explored. Major hardware and software based energy saving capabilities will be analyzed and discussed.

Worldwide, most of current ICT equipment are not (even partially) properly recycled. But properly processing electronic waste is mandatory if we want to efficiently influence ICT lifecycle. This talk will present some examples and explore the effect of applying good practices in recycling.

As second part, this presentation will also explore potential energy savings provided by ICT which can impact other sectors due to large scale. From visio conference to social networking, ICT can support new range of services helping to reduce their potential impact on climate change. But these services must be carefully exposed and analyzed in order to support a full understanding of their benefits.

P-3305-13
An ex-ante quantification of the Energy Efficiency Gap
E. Ó Broin (1) ; É. Mata, (2) ; J. Nässén, (2) ; F. Johnsson, (2)
(1) CIRED, Nogent-sur-Marne, France; (2) Chalmers University of Technology, Energy and environment, Göteborg, Sweden

This work presents a methodology for estimating ex-ante the energy efficiency gap and key related energy system parameters. An ex-ante quantification of the 'energy efficiency gap' is defined as the difference between market and techno-economic potentials. The ex-ante market potential is estimated from coefficients established with a top-down (econometric) modelling of energy demand using data from the period 1970 to 2005 (Ó Broin et al, 2015). The ex-ante techno-economic estimates are made using a bottom-up building stock model (eCCaBs) that assesses the effects and cost-efficiency of various energy efficiency measures (Mata et al, 2013). We implement the method for the case of useful energy demand for space and water heating in the Swedish residential sector up to 2030.

Background: The true size of the energy efficiency gap remains unclear (Gillingham and Palmer, 2014). Findings from research on the energy efficiency gap could help policy makers generate social and private benefits from accelerating the diffusion of energy-efficient technologies (Chapman et al., 2014). Although the general thrust of contemporary research on the energy efficiency gap is focusing on empirical studies that describe decision making among heterogeneous energy-users (Gillingham and Palmer, 2013) the authors of this work believe that there is also a need for system-level or sector-level studies which can give insights into key system-level parameters affecting the adoption of efficiency technologies, such as energy prices and discount rates. Furthermore, although the historical failure of the techno-economic energy efficiency potentials to be realised has well been documented ex-post, few, if any, studies have undertaken ex-post measurement potentials, with the intent of learning from the comparison of the market and techno-economic potentials.

Results: In comparison to the level of energy use in 2005 (74 TWh), the top-down model predicts a 2030 reductions in demand of 21 TWh. The bottom-up model predicts corresponding reductions in demand of 31 TWh. Thus there is an energy efficiency gap calculated of 10 TWh in 2030. An implicit discount rate of 10% would render the results from the bottom-up modelling identical to those from the top-down modelling. Conversely a decreasing historical discount rate the economic diffusion and conservation through, for example, support schemes and regulations, would render the results from the top-down modelling identical to those from the bottom-up modelling.

Increasing energy prices as a policy measure, as implied in this work, does not lead to a proportional increase in additional savings, as shown by the top-down model. The combination of high energy prices and a long-term price elasticity of 0.29 would ceteris paribus result in a decrease in demand of only 4 TWh by Year 2030 as compared to a low energy price scenario, this suggests that while higher energy prices may achieve a global carbon target or cover the requirements of a Pigovian tax, at the residential sector level they are not so effective. The findings of this work i.e. the magnitude of the implicit discount rate; the price elasticity; and the size of energy gap; provide useful guidelines for formulating individual country and regional climate and energy goals.


P-3305-14
A design matrix for energy sustainability of buildings with double skin envelopes in warming climates in the tropics
U. Rajpakshaka (1) ; H. Rupasinghe (1) ; I. Rajpakshaka. (1)
(1) University of Moratuwa, Architecture, Moratuwa, Sri Lanka

Adapting buildings to extreme temperatures due to climate change, demands a collaborative effort to deal with climate, occupants and buildings. A current technology to assist with this approach is called “bio-climatic design approach”. This design approach is an appropriate base for climate responsive design which involves the way buildings filter the climate for occupants’ comforts. This approach has gained recognition for the potential in medium scale buildings in moderate climates. However, this is less researched and problematic due to indoor overheating potential in warm humid climates. Thus needs to be investigated in the effort of adapting buildings to warming climates.

The project will contribute to establish that building design can play a key role in combating extreme temperatures involving a shift towards new bio-climatic design solutions focusing on passive climate control with form and fabric of buildings. The method used in this research reviews trends in predicted climatic behaviors in tropics, and evaluates critical practice exemplars found in local climatic zones in Sri Lanka. The project presents a generalized matrix of evidence-based interventions from associations that publicize case studies and literature exploring the potential for adapting buildings to predicted extreme climates. Use of onsite investigations, and advanced computer-based Design-Build simulations for assessing and predicting adaptive capabilities of buildings will become essential components of the method.

Innovative potential of envelope dependency, which optimizes the building-climate interplay for reducing the need for energy in building operation, is highlighted with the matrix. This is more complex and critical when envelope dependency is not fully resolved in buildings located in the tropics where environmental loads external to the buildings contribute more significantly to the thermal load profiles of buildings. Unresolved envelop dependency contributes to indoor overheating in many ways. The paper takes this challenge by developing a cross-dimensional performance approach of buildings focusing on the dependency of the microclimate, plan form, sectional form and envelope.

An integrated characterization of energy sustainability of buildings is proposed based on the matrix, which is a conceptualization of built environment as building-climate-occupancy system. The matrix aims at strengthening envelope dependency of a building considering it as a bio-climatic entity contributing to
sustainability and low emission building practices. One holistic performance indicator for evaluating such contribution, so expressing the climate modification – the reduction from ambient to internal air temperature. Discussion on the efficacy of the matrix shows that it works as an empirical tool supporting to gaining an insight in resolving any dualities associated with performance within the envelope dependency.

The research found that most certified green buildings in the country are either of core dependent or envelope dependent but highly energy intensive. Methodology involved few field investigations of selected certified green buildings using data loggers that collected air temperature, radiation, wind flow and envelope surface temperatures and the use of a computer based Design-Build simulation program. Empirical findings showed the criticality of the problem and unresolved duality associated with envelope dependent forms – heat gain Vs passive influence. The buildings are found to be highly energy intensive with an Energy Utility Index around 196–260 KWh/m²/a although they are certified either as Gold or Platinum. Research further showed indoor overheating situations when buildings were allowed to run free without air conditioning.

The simulation program used to redefine the energy sustainability of the most critical case building introducing resolved dependency involving a high thermal mass double skin external envelope and a vertical atrium for thermal buoyancy effect. Calibrated simulation results provide evidence of passive cooling with internal air temperatures in all multi levels of the building moving 2–3.5 degrees C below the ambient levels due to improved and resolved envelope dependency with heat removal, stack force and night ventilation. Findings showed a reduction of 80 KWh/m²/a suggesting that the matrix can play a positive role in innovating envelope dependency for emission reduction.

P-3305-15
The importance of the sun as clean source of energy in the design of cold storage for health care facilities in Africa
MRD. Seke (1)
(1) University of South Africa, Mechanical and Industrial Engineering, Gauteng, South Africa

Sun is the main source of energy to several planets, especially to the Earth and its inhabitants. It lightens the surface of the Earth free of charge, and its energy is clean.

However, we do not fully benefit from the sun’s energy which is precious to the humanity and can be used as the best source of energy. The Universe, the atmosphere, seas, forests and soils benefit is more than billions of Joules per year.

Africa is a place of hope and has a better position in term of climate change but its population, in majority, is poor and exposed to variable viruses, diseases and threats which are still killing due to lack of access to cure and drugs of quality.

In laboratories where medicines are manufactured and in hospitals where human bloods are collected and stored to both improve and better the conditions of patients, we need their good preservation either in transit or in storage.

In rural and urban areas, solar powered cold room units would be of wide benefit to the healthcare facilities.

This study is based on theoretical analysis and calculations of Solar Powered Cold storage for healthcare facilities in Africa, as well as some comparisons made between different sources of energy to keep thermolabile medicines and blood bags in good conditions according to the pharmaceutical uses and health standards.

As the future of the Earth depends on its ecosystem, the gratuity of the solar multi levels of energy is the precious fuel which led our design project.

The methodology used in the present study employs both qualitative and quantitative research techniques.

P-3305-16
Strategic policy packages to deliver energy efficiency in buildings – theoretical analysis and international evidence
S. Thomas (1) ; V. Aydin, (2) ; D. Kiyar, (2) ; L. Tholen, (2) ; M. Venjakob, (2)
(1) Wuppertal Institute for Climate, Environment and Energy, Germany; (2) Wuppertal Institute for Climate, Environment and Energy, Wuppertal, Germany

Energy efficiency in buildings and appliances has the potential to halve the energy consumption and greenhouse gas emissions from that sector by 2050, despite growth in building and appliance stock. However, this potential will not become reality without policy support, due to complex market chains with many types of actors, and a plethora of barriers they face. What are, then, effective packages of policies and measures to stimulate energy efficiency in new and existing buildings, and appliances? In recent research, we have addressed the question in a systematic way – by combining theoretical evidence on what policy support markets need, and an international comparison on which packages of policies have worked well.

On the theoretical side, the analysis starts with the barriers but also market–inherent incentives that the different types of market participants face. This enables to derive a recommended policy combination taking the types of regulatory, economic and other policies and measures the actors need to overcome all these barriers and strengthen incentives. On the empirical side, we find evidence of good practice for policy packages has been collected and their design and impact compared, to check if advanced countries have indeed used the combination of policies we derive from the theoretical analysis. In this way, we learned from it for effective packages and implementation.

In this way, we found that the recommendable policy package for new buildings is similar to the well–known one for appliances, but with the objective to mainstream nearly zero energy buildings. By contrast, the task for existing buildings is two–dimensional – increasing the depth of renovation first, to savings of 50 to 80%, and then the rate of energy–efficient renovation to 2% or more p.a. – and so the policy package needs more emphasis on individual advice, incentives, and financing. The paper will present the recommended packages as well as a comparison of existing national policy packages from Denmark, Germany, Singapore, Tunisia and what we learned from it for effective packages and implementation.

P-3305-17
Solutions for the improvement of energy efficiency in historic buildings and districts preserving their heritage value
A. Vivarelli (1) ; A. Bernardi (1) ; F. Becherini (1) ; MC. Di Tuccio (1) ; L. Pockele (2) ; T. Broström (3) ; E. Schoenberger (4)
(1) National Research Council, Institute of atmospheric sciences and climate, Padova, Italy; (2) R.E.D. srl, Padova, Italy; (3) Uppsala University, Gotland, Sweden; (4) Fraunhofer Institute , Building physics lbp, Holzkirchen, Germany

Buildings have a significant impact on energy use and environment. Growth in population, increasing demand for building services and comfort levels, together with time spent inside buildings, assure that the upward trend in energy demand and CO₂ emission will continue in the future. This situation is strongly related to the emissions from existing buildings, as 50 million buildings throughout Europe are 50 years old or more. Europe can become the leader in CO₂ emission reduction by applying innovative energy efficient solutions to its built historic and cultural heritage. However, most of the current developments in energy efficiency typically address new constructions and individual buildings without considering on one hand the unique problems of historic structures and on the other hand the urban dimension.

These issues are faced within the research project EFFESUS (Energy Efficiency for EU Historic Districts’ Sustainability), funded by the European Union 7FP (Grant Agreement no.
Fixing or transferring environmental problems in the transport sector?

H. J Walnum (1)

(1) Western Norway Research Institute, Environmental group, Sogndal, Norway

Worldwide, the transport sector produced 7.0 GtCO2eq of direct greenhouse gas (GHG) emissions, which corresponds to approximately 23% of the total energy-related CO2 emissions. In general, the EU transport sector was responsible for 25% of the energy-related GHG emissions. Although the recently adopted EU target is to reduce GHG emissions levels by 80%-95% from 1990 levels by 2050, the EU transport sector will contribute considerably. The main output will be a Decision Support System (DSS) that provides a framework for decision-making.

The scope of the thesis is to examine how rich countries, such as the U.S. and the EU, can achieve sustainable mobility, taking into account the problems related to various transportation modes. The thesis is based on the idea that transportation demand is not only driven by transportation policies but also by socio-economic factors. The DSS methodology is based on indicators, i.e. qualitative and/or quantitative information associated to the retrofit process under observation, which allows to verify the alignment of the goal of the related inputs with the expected outputs. These indicators are evaluated on a five point scale both for the initial conditions of the existing stock and for the conditions after the implementation of the interventions. The Decision Support System (DSS) will be piloted in five case studies, where the possible retrofit measures are prioritized in function of their potential impact, with the aim to assist stakeholders in decision-making. The DSS will be based on real data including also climatic change predictions.

The applicability of the technological developments, as well as the suitability of the DSS are being demonstrated in five case studies. In particular, the following innovations are being tested: new thermal insulating mortars for use as plaster and render in Benediktbeuern (Germany); radiation selective coatings for outdoors in istanbul (Turkey), blown-in aerogel for use in cavities behind existing wall finishes in Glasgow (United Kingdom); windows with improved insulation and ventilation, as well as intelligent indoor climate solutions through energy management algorithms in Budapest (Hungary); implementation of new control strategies to decrease the primary energy demand in historic buildings and districts in Santiago de Compostela (Spain).

The preliminary results of the performance assessment of the new technologies developed in EFFESUS will be presented mainly in function of the indoor environmental conditions and operational energy indicators on the basis of the monitoring activities carried out in the above mentioned five case studies. These activities have been launched at the beginning of the research project and are now running for several months. The parameters, defined in function of the technology to be validated, are currently being measured simultaneously in all areas and in an equivalent reference area for reasons of comparison. The only exception is in Benediktbeuern where the comparison is performed before and after the application of the thermal insulation mortar. In particular, the thermo-hygrometric conditions (temperatures, relative humidity, and air flow) and the energy related parameters (heat flows, energy consumption, associated cost of the energy, etc.) are being studied. These data are being used to test the performance of the new technologies and to evaluate the energy savings in terms of: indoor comfort expressed as PMV and PPD values (EN 15251), air quality (CO2 levels, ventilation rate), percentage of reduction of energy consumption, contribution of RES to the buildings and districts energy demand for heating/cooling, district heating contribution to the buildings/district energy demand.

Reducing Methane Emissions Using a Fixed Bed Reactor Under Dynamic Condition

E. Wardhono (1); M. Effendy (2)

(1) University of Sultan Ageng Tirtayasa, Chemical Engineering, Cilegon, Banten, Indonesia; (2) Surabaya State University, Mechanical engineering, Surabaya, Indonesia

The production and use of gas is the largest human-made source of methane emissions in Indonesia and the fourth largest globally. Methane is referred to as a potential greenhouse gas because it has a Global Warming Potential, GWP, of 21. This means that methane is 21 times more powerful than CO2 at trapping heat in the atmosphere over a 100-year period. Methane emissions primarily result from normal operations, routine maintenance, leaks and system upsets from connections between pipes and vessels or to valves and equipment. Reducing these emissions can have significant environmental and economic benefits.

The catalytic treatment is one of the most reliable alternatives to reduce of methane emissions. However, due to the concentration of emitted methane is low,
the flow rate changes over time and the temperature is increased, the control of fixed bed reactor operating under steady state conditions is less appropriate. For methane contents of 0.5%-v, the adiabatic temperature rise is approximately 115°C. A result, extra external energy is required to increase the temperature of the feed gas. Reverse flow reactor was applied to overcome this problem. To increase of methane conversion may be induced by changes of the reaction rate over Pt/γ-Al2O3 catalyst surface due to dynamic system operated at proper time scale. Therefore, there are two important aspects to be considered: (1) reactor design and (2) operation method. The aim of this study was to develop a new method in order to determine the reaction mechanism and rate-controlling step that occur in one dynamic cycle. The reaction rate obtained was methane oxidation using 0.3%-wt Pt/γ-Al2O3 operated under steady state condition. At the same time, the reaction rate of the reverse flow reactor was approached using a once-through direction of fixed bed reactor with composition modulation. It was based on the similarity of the reactor’s response measured at the outlet, which is usually used for sampling.

The method used in this study was a steady state approach consisting of 4 stages; (1) the first stage was to determine the homogeneity of the continuum model of a fixed bed reactor that will be used to validate the model reaction mechanisms and dynamic model used to simulate the dynamic conditions. (2) The second was determination of the model reaction mechanisms and rate-controlling step of the steady state condition. (3) The third was to identify the influence of the perturbation on the response of the reactor in term of conversion in the dynamic condition. Furthermore, the validation of the model reaction mechanism obtained at steady state on methane conversion obtained in the dynamic condition was performed. (4) the fourth stage one was to establish the model reaction mechanisms and dynamic experiment data were indispensable.

The influence of the perturbation on response inducing the dynamic conditions in the reactor can be expressed by the reaction rate over Pt/γ-Al2O3 catalyst with methane conversion obtained. The use of the model reaction rate over Pt/γ-Al2O3 catalyst provided a basis for determining the necessary incentives for computing the change plots and rate-controlling step in one cycle period. Furthermore, the validation of the model reaction mechanism and dynamic kinetic parameters with dynamic experimental data were indispensable.

The deviation in term of error obtained was very large, i.e. 40%. In one cycle of dynamic operation, there were three mechanisms of reaction involved, i.e. the total oxidation of methane to CO2 and H2O, the partial oxidation of methane to CO2 and H2, and the decomposition of methane to CO and H2. The transition of reaction mechanism in one cycle of dynamic operation was based on the ratio changing of the concentration of CH4/O2 due to feed composition modulation applied.

P-3305-20

Mapping and Modelling multiple benefits of energy efficiency and emission mitigation in China’s cement industry at the provinces level

S. Zhang (1); E. Worrell, (1) ; W. Crijns-Graus (1)

(1) Copernicus Institute of Sustainable Development, Department of Innovation, Environmental and Energy Sciences, Utrecht, Netherlands

China’s cement industry is the second largest energy consumer and key emitter of CO2 and air pollutants. It accounts for 7% of total energy consumption in China and 13% of CO2, 21% of PM, 4% SO2 and 10% of NOx of national emissions. At the same time, efforts in energy consumption and emissions of CO2 and air pollutants in China’s cement industry are rarely quantified. In this study, an integrated assessment model including provincial energy conservation supply curves (ECSCs), (which can be used to calculate the air pollutant emissions), and ArcGIS (a geographical information system (GIS) with elaborated spatial functions) is developed and used to assess the potential of energy savings in terms of emission reduction of CO2 and air pollutants (i.e. PM, SO2, and NOx) in the next two decades. Seven provinces (i.e. Shandong, Sichuan, Jiangsu, Guangdong, Zhejiang, Henan, Hebei), six of which are located in the central– and east-- China, account for 47% of the total energy saving potential, equivalent to 26% of baseline energy use in 2030. The energy efficiency measures can help decrease 38% of CO2, 23% of SO2, 33% of NOx, and 26% of PM emissions in these seven provinces by 2030. This indicates that the multiple benefits should be considered when local policy makers or end users make decisions whether to implement the energy efficiency measures to solve environmental issues.

Abstract Book 2015, 473
the climate may be no better off because of it, given the affected diversity of biota and ecosystem services. Further, analyses show that globally agreed mitigation policies could lead to a major reallocation of financial flows between regions, in terms of expenditures on fossil fuel extraction and infrastructure. Carbon leakage could become a concern under fragmented policy environments; and carbon lock-in and the eventual premature retirement of fossil infrastructure are realities to be mindful of if major mitigation efforts are delayed beyond 2020.

K-3306-02

The market and lock-in effects of new fossil fuel infrastructure, and the need to integrate supply- and demand-side climate policies

P. Erickson (1); L. Michael (1)

(1) Stockholm Environment Institute, Seattle, United States of America

Climate policy and analysis often focus on energy production and consumption, but seldom consider how fossil fuel supply and transportation infrastructure shape energy systems. US President Obama, among others, has recently highlighted these issues. In this presentation, based on our paper in Nature Climate Change (doi:10.1038/nclimate2335) we show how such infrastructure investments, through market effects, could affect fuel use and global GHG emissions on a scale similar to national policies aimed at reducing fossil fuel consumption and GHG emissions. We contend that in order to increase the effectiveness and efficiency of meeting climate protection goals in the coming decades: (1) examination of supply-side investments and their implications for fuel markets, consumption, and emissions, needs to be undertaken widely and systematically; and (2) policies and mechanisms need to be considered and integrated with more typical, demand-side climate policy. The presentation will synthesize insights from recent literature (e.g., Erickson and Lazarus 2014, Collier and Veenables 2014, Faehn, Hagem, et al 2013, McGlade and Ekins 2015), and suggest areas for further inquiry and action for research and policy communities.

K-3306-03

Commitment accounting of CO2 emissions: long-term consequences of current investments

S. Davis (1)

(1) University of California, Department of earth system science, Irvine, CA, United States of America

Any limit on future global warming is associated with a budget of cumulative CO2 emissions, such that annual global emissions must ultimately approach zero. Yet, unless retrofitted or retired early, currently new and existing fossil fuel-burning infrastructures commit us to future CO2 emissions over their expected lifetimes. I present results from the report 'How would new fossil fuels affect the climate?' by Davis and Socolow [1] and Raupach et al. [2], which together describe trends in committed emissions related to energy infrastructure and how these commitments could force future energy systems to operate under different climate targets and the options for sharing this budget among nations. Next, I’ll show how the expansion of economic fossil fuel reserves (e.g., by exploration, innovative extraction methods, or improved transport infrastructure), may also represent commitments to extract and burn these fuels [3]. Finally, I’ll discuss the required carbon intensity of new investments given the constraints of a cumulative carbon budget and existing capital stock, with explicit comparisons to a range of top-down energy-emissions scenarios. The combination of such top-down global scenarios and bottom-up appraisals of real-world trends may help inform policies that minimize lock-in and break fossil carbon lock-in (or stranded assets).


O-3306-01

A global abundance of natural gas increases the challenges of climate change stabilisation

J. Hilaire (1); N. Bauer (1); E. Kriegler (1); L. Baumstark (1)

(1) Potsdam Institute for Climate Impact Research, Potsdam, Germany

The US economic gains and carbon emission reductions associated to the recent US shale gas boom are frequently mentioned to portray natural gas as a bridge technology to a low-carbon future. Having half the carbon footprint of coal, natural gas seems indeed an attractive carbon mitigation option. As a result, several countries including China, India, Mexico, Poland and the UK are seeking to take advantage of the low technology associated with natural gas (e.g. hydraulic fracturing, horizontal drilling …) and replicate the US development. If successful, this collective endeavour could bless the world with a global abundance of natural gas that would lead to a “golden age of gas”. Regular upward revisions in natural gas resources – and decline in associated extraction costs – support the possibility of such future. Moreover, should global warming be limited to below 2°C with high probability, the global gas bonanza would have to occur simultaneously with a global energy transition aiming at reducing worldwide greenhouse gas (GHG) emissions to zero or below by 2100.

Economic theory suggests that the global energy transition can be efficiently orchestrated by setting a global price on carbon emissions. Nonetheless a global carbon price regime is still subject to fierce debates during climate negotiations and will most likely be implemented with a several year delay. Currently, the climate political landscape consists of multi-national carbon markets and national technology policies. In this context, can a global abundance of natural gas facilitate the global energy transition by reducing its costs, fostering the deployment of low-carbon technologies and reducing CO2 emissions? We address this question by generating various scenarios with a global model of the energy–economy–climate system. These scenarios differ along two dimensions: the degree of natural gas supply and the delay to implement a global carbon price consistent with a 2°C target. Our results show that seeking to expand natural gas supply whilst trying to protect the climate would bring short-term benefits such as higher GDP, lower electricity prices and reduced short-term mitigation costs. However it would also increase medium- and long-term mitigation costs substantially, or at least in the absence of international cooperation, hence higher CO2 prices. Differences in aggregated discounted consumption losses over 2011–2100 between an abundant—gas and a conventional—gas world amount to more than 0.25 percentage points.

Interestingly, living under a “golden age of gas” increases the opportunity costs of climate change mitigation, partially because of lock-ins in natural gas technologies. This can be seen by looking at differences in GDP growth reduction. Even though GDP growth is only marginally reduced by an increase in natural gas supply over 2015–2030, this reduction becomes much larger over 2031–2050. More importantly, a delay in comprehensive climate policies leads to more than a quadrupling in GDP growth reduction over 2031–2050, compared with immediate climate action. Consequently not only climate change stabilisation becomes more challenging to achieve in a gas–abundant world but it is even more difficult when climate protection is delayed.

O-3306-02

South Africa’s planned coal infrastructure expansion: drivers, dynamics and implications for carbon emissions

J. Burton (1)

(1) University of Cape Town, Energy Research Centre, Cape Town, South Africa

South Africa has both domestic climate mitigation objectives and has pledged internationally to reduce its
Recent work has illustrated the geographic distribution of ‘unburnable’ fossil fuel reserves under climate policy constraints (McGlade and Ekins, 2015). Natural gas is often referred to as a transition fuel but typically with little specific qualification of quantities of consumption, rates of transition and end point targets. All of these aspects can be informed by a national cumulative emissions budget approach (e.g. Friedlingstein et al, 2014). We therefore consider national and temporal dimensions of unconventional oil and gas production and consumption taking the UK case of shale gas development as an illustrative example. Recoverable quantities are found to be substantially lower than anticipated in UK energy policy discourses. The evidence and arguments presented are largely applicable to other unconventional gas resources such as coal bed methane (CBM), underground coal gasification (UCG) and shale oil, in other Annex 1 (industrialised) nations.

Shale gas and shale oil are fossil fuels produced by hydraulically fracturing, ‘fracking’, impermeable shale strata. Gas and oil residing in these and similarly impermeable reservoirs, such as coal measures, are termed “unconventional” resources. Technological developments in this area have substantially increased expectations of recoverable fossil fuel resources (McGlade et al 2013). The scope for unconventional oil and gas production and consumption in Annex 1 countries to contribute efforts to avoid the 2°C characterisation of dangerous climate change has been outlined to date (Broderick and Wood, 2014). Under reasonable assumptions of national and sectoral apportionment, the simple arithmetic of emissions budgets make it clear that Annex 1 nations require a transition to a low carbon energy system in the next two decades (Anderson and Bows, 2011). This limits the time available over which unconventional resources may be extracted and combusted and hence quantities likely to be recovered under a stringent climate regime. We quantitatively illustrate this in relation to existing UK regulations, structured by the Climate Change Act (2009), and the emissions budgets arising. Conditions for oil and gas export, including a quantitative assessment of the prospects for carbon capture and storage (CCS), are then discussed in relation to global emissions budgets and recent developments in the US energy industry.


Energy security and climate policies: An unequal marriage

J. Jewell (1); A. Cherp (2)
(1) International Institute for Applied Systems Analysis, Laxenburg, Austria; (2) Central European University, Department of Environmental Sciences and Policy, Budapest, Hungary

The quest for energy security and concerns over climate change caused by greenhouse gas emissions are top energy policy priorities worldwide. To complement the growing body of literature on energy security implications of climate change mitigation, this paper examines the two-way interaction between pursuing energy independence and reducing greenhouse gas emissions. Using 5 state-of-the-art energy-economy models and 6 long-term global scenarios, our analysis calls for closer and more thoughtful coordination between these policy priorities. First, we show that the pursuit of ambitious yet realistic energy independence targets would result in an insignificant reduction of greenhouse gas emissions (5%–15% over the 21st century compared to the Baseline) that will not be sufficient for achieving even the current modest climate pledges. In other words, the climate will not be saved as a ‘side-effect’ of energy security policies. Second, fulfilling the existing climate pledges would not significantly affect energy imports of major economies though pursuing stringent climate stabilization targets would radically reduce these imports. Third, the modeled energy independence targets could be achieved at policy costs comparable to those of the current climate pledges but ten times lower than those of the stringent climate policies. In other words, advocates of cost-efficient energy independence may have little reason to support either stringent climate policies (because of their significantly higher costs) or current climate pledges (because of their relatively minor impact on global energy.

Key Issues in Energy, Climate Change and Environment

C. Lee (1); A. Liwayway (1); D. Best, (1); C. Hood, (1); E. Levina, (1)
(1) International Energy Agency, Paris, France

Policies that respond to climate change and other environmental issues will increasingly impact the development of the global energy sector. The transition to low-carbon economies will need to be carefully managed, as the provision of secure, affordable energy is critical for economic growth and social development. More than ever, there is a need for a fuller understanding of the opportunities to promote synergies between energy, environmental and climate policies.

Energy, Climate Change, and Environment: 2014 Insights helps address this need with indepth analysis of selected policy questions at the energy-climate interface, including:

- How can we accelerate the transition from (i.e., “unlock”) existing high- emissions infrastructure?
- What are the best ways to design cost-effective emissions trading systems that fit with national circumstances?
- What are some alternative energy-specific metrics that support near-term emissions reductions and long-term decarbonisation of the energy sector?
- And, in the special focus of this report, can curbing local air pollution help reconcile energy priorities with environmental sustainability, including greenhouse gas mitigation?

Addressing these questions will help inform decisions that can boost decarbonisation of the energy sector while taking into account security and economic objectives. This report also features an update of key energy and emissions statistics for ten world regions that should interest energy practitioners and climate policy makers alike.

The 3 CRISIS: EEE (ENERGY, ECOLOGY AND ECONOMY)

G. Quartieri (1); E. Chavez (2)
(1) IUSR http://www.unisrira.it, PHYSICS, SAN PIETRO INFINE (Caserta), Italy; (2) National University of San Marcos, Faculty of Veterinary Medicine, OIKOS Association., Lima, Peru

Our common future is conditioned by three World crisis: Energy, Ecology and Economy ones. To face them it is necessary to implement an inter disciplinary approach capable of finding the interlink of these three issues. The present paper wants to apply system Σ approach to discover the possible connections among energy, ecology and economy disciplines. Those linkages should be able to propose change and unveil possible hidden interlinks.

System approach implies define, operation and control of overall and global Σ system defined by its structure Σe, its specific parameters ΠΣ and its variability ΨΣ. The system Σ depends upon EEE: Σ = f (E, E, E). Out of the three crisis, the first and most important one is the energy that has a urgent need for real and right definition of cost, relation, availability, and proportion among fossil (oil, gas and coal), renewable and nuclear sources. Second one is the ecology with an holistic approach to the ecosystem services and their importance in the sustainability due to its inherent importance in different climate scenarios.

The third one is the economy. In this global context, paramount is the economy deception that acts and works as director. Knowledge and information economy appears to be the most probable way to cope with common future overcoming the economy deception phase and present difficulty. Quality of life has been improved according to almost exponential pattern during past ages. However, human quality of life is nowadays strongly influenced by the good bad Environmental Impact Factor I = PXAXT, in different Countries (super-developed, developed and under-developed and so on) of the World. Same approach is valid for all the biodiverse beings. There is a strong need of interlinks among these three main concepts of EEE. From the history point of view the classical main causes of World degradation, by starting with population reduction, have been wars, pestilences and famines. To cope with a better future, these main causes can and must be avoided starting with a strong improvement of science, knowledge and information among people.

Consequently, the solution for an appropriate common future is to build a new economy based upon undeceived energy and ecology (including biodiversity) knowledge and information among people all over the World. To these purposes and to get over the EEE crisis, the holistic approach i.e. the system Σ approach has to be applied in order to delete deceptions anywhere and anytime.

3307 - Negative emissions for climate change stabilization & the role of CO2 geological storage

ORAL PRESENTATIONS

K-3307-01 (part1)

The concept of negative emissions

S. Fuss (1)

Future warming is contingent on the cumulative CO2 emissions until 2100. A maximum of 1,200 GtCO2 can be emitted from 2015 onwards in order to stabilize climate below a global average of 2°C above pre-industrial conditions by 2100 with a probability of 66%. At the same
Carbon dioxide Capture and Storage (CCS) is recognized in the IPCC's 5th Assessment Report as part of the mitigation technology portfolio that must be deployed in order to reduce CO2 (carbon dioxide) emissions and keep the global average temperature change to less than 2°C relative to pre-industrial levels. Enhanced oil and gas reservoirs, CO2 captured at plants in the fossil-fuel energy, bioenergy and industrial sectors is a promising option to reduce emissions into the atmosphere by returning the initially extracted carbon back to the ground, and may also be used to remove CO2 from the atmosphere.

The CCS concept to mitigate emissions from fossil-fuel and biomass fired power plants and from the processing and cement industry consists of three main components; the capture installation, transport infrastructure by pipeline or ship and geological storage structures in the deep subsurface. Prominent deep saline aquifers and depleted oil and gas fields. In Europe, the North Sea region which is rich with oil and gas reservoirs, offers a promising area for CO2 storage. Several countries around the North Sea are developing plans for CO2 storage activities including the United Kingdom, Norway, the Netherlands and Denmark. Demonstration of CCS is developing at great pace in North America. Recently, the large integrated CCS project Boundary Dam started to operate in Canada.

Inventories of storage potential presented in atlases and Geographical Information System (GIS) databases and maps have been performed in many areas of the world including the USA, Australia and Europe showing that there is more storage than the current policy framework. Storage potential in Europe has been estimated at 360 Gt CO2, 244 Gt of which is available in the offshore region (GeoCapacity project, 2009). The challenge is to test the effective storage capacity of geologically suitable storage media through detailed characterisation and field testing, moving from a resource estimate towards a reserve estimate.

The technology for CO2 storage is largely derived from the oil and gas industry including evaluation of reservoir performance and drilling technology. Underground storage of natural gas in diverse media is a widespread and common practice in many regions. In the nineties several storage projects have been developed e.g. the large-scale storage of CO2 in the Norwegian offshore. On land, several CO2 storage pilots, in different stages of development are present e.g. in Spain and Germany. The challenge is to demonstrate large-scale CO2 storage integrated into a full CCS chain project. Several projects for large-scale demonstration of CCS in the offshore sectors of the UK and the Netherlands are in the preparation phase.

The cost of CCS is estimated at 60 to 90 Euro per tonne CO2 in the demonstration phase (reference year 2015) which could drop to 30 to 45 Euro for projects at an early full commercial scale stage (reference year 2030; McKinsey, 2008). The costs of storage in the early commercial phase range from 4 to 12 Euro per tonne of CO2, depending on the location and the type of storage structure (McKinsey, 2008). Lowering the costs of the capture installation is the biggest challenge. Financing of CCS projects is currently faced with the low price of emission allowances of less than 7 Euro per tonne CO2 (EEX, 10 March 2015). An effective CCS enabling policy with a mature emission trading market is needed.

Containment of the injected CO2 in the reservoir is a prime requirement for CCS to be an effective CO2 abatement technology. For this reason modelling and monitoring of the CO2 in the subsurface receives a lot of attention. The European CCS Directive addresses the key aspects of safe and environmentally sound CO2 storage. The current Directive seems to be fit for purpose but needs more extensive testing in real-life CO2 storage projects.

The public at large is not well informed on CCS technology and its object of abating CO2 emissions. In onshore sectors, people sometimes have more confidence in this new technology, like in some initiatives in Germany and the Netherlands. In other instances, like for the CO2 storage pilots near Hontomin in Spain and near Ketzin in Germany, the local people show a positive interest in these activities. Participation of the public from an early stage of project development onwards is key to making people aware of CCS and getting them engaged in these projects.
O-3307-01 (part1)

Enhanced weathering and BECCS - are carbon dioxide removal technologies complements or substitutes?

J. Strefer (1) ; N. Bauer (1) ; T. Amann (2) ; E. Kriegler (1) ; J. Hartmann (2)

(1) Potsdam Institute for Climate Impact Research, Sustainable solutions, Potsdam, Germany; (2) Universität Hamburg, Hamburg, Germany

In its fifth assessment report, the IPCC stated that scenarios which “are consistent with a likely chance to keep temperature change below 2°C relative to pre-industrial levels [...] are characterized by [...] emissions levels near zero GtCO2eq or below in 2100” (Edenhofer et al., 2014, Summary for Policymakers, IPCC 5th Assessment Report of Working Group III). To reach such low CO2eq emissions, net negative emissions will be necessary in some sectors to compensate for e.g. CH4 and N2O emissions from the land-use sector or industry process emissions. There are at least four options to achieve net negative CO2 emissions: The combination of bioenergy with carbon capture and storage (BECCS), afforestation, direct air capture, and enhanced weathering of rocks.

Enhanced weathering (EW), the deployment of finely ground minerals over forests and crop lands, could be used to remove CO2 from the atmosphere. It faces neither the technological nor the social risks of the other options. However, olivine, the mineral that is best suited, might be contaminated by potentially harmful trace elements. Other sources like basalt can have lower harmful element concentrations, but show lower CO2 sequestration potential.

Our research questions are: What are the optimal design parameters for EW? How does EW as a mitigation option interact with BECCS?

An important parameter that determines costs as well as carbon removal rate is the grain size. We first calculate an optimal grain size that maximizes profits, taking the dependency on carbon removal rate and costs into account. Then we calculate the discounted net present values for the implementation in the integrated assessment model REMIND and show preliminary results of EW as a mitigation option.

When EW is available as a mitigation option, it provides net negative CO2 emissions which allow for higher CO2 emissions earlier in the century. The slower reduction of CO2 emissions results in a lower CO2 price and therefore lower mitigation costs. We will analyze under which conditions EW is used as a substitute or complement to BECCS. In addition, we will analyze scenarios where CCs is not available. In combination with a stringent climate target, these scenarios often show very high mitigation costs or become unachievable. We will investigate to what extent EW can substitute BECCS in this case.

Addressing technical and resource challenges in delivering negative emissions

J. Gibbins (1) ; H. Chalmers, (1) ; M. Lucquiaud, (1)

(1) University of Edinburgh, School of Engineering, Edinburgh, United Kingdom

Approaches that remove carbon dioxide from atmospheric air are likely to be an essential enabling ‘backstop’ technology for a world that has to keep within a fixed carbon emissions budget to avoid dangerous climate change. Such technologies must be available to be scaled up if necessary to deliver the required carbon dioxide (and other greenhouse gas) emission trajectories.

Present technology can deliver carbon dioxide removal (CDR) or ‘negative emissions’ using biomass with ‘conventional’ CO2 capture and storage (BECCS). BECCS is the most likely to be available first as it is a relatively mature technology. For example, battery electric vehicles using BECCS electricity production provide a highly efficient route for using a wide range of biomass materials in transport compared to conversion to liquid fuels. Adding carbon dioxide capture and storage would give a further negative CO2 emission of about 125 g/km to set against other lifecycle emissions. In buildings, rather than using biomass directly for heating, options to use it for power, to give similar results if used to generate electricity that can then power heat pumps, plus give negative emissions when combined with CCs.

Although BECCS can make a useful contribution to mitigating the risk of dangerous climate change it cannot be regarded as a robust backstop technology. Especially in a climate-stressed world it cannot be regarded as a robust backstop technology. Especially in those scenarios where sufficient amounts of biomass will be available for this to be the only route. Here Direct Air Capture (DAC) by engineered systems that can be multiplied as required using mass-produced standard components appears to be an essential option for many societies.

In a number of cases DAC facilities are likely to be combined with power plants with CCs. They can share CO2 transport and storage facilities and hybrid technologies would be used also to reduce residual CO2 emissions from the fuel in the power plant to very low levels. DAC technologies can also, however, be located elsewhere. For example, developers could choose to locate DAC facilities close to CO2 storage sites to minimise time and cost associated with establishing CO2 transport infrastructure and also to optimise the use of global storage resources.

Costs for DAC technologies currently being proposed may appear high. But in the context of cancelling out emissions from hard-to-avoid liquid fuel use (as an offset or via fuel synthesis) estimated additional costs are of the order of 1 euro per litre. Some or all of this cost may be offset against reductions in oil prices if there is no other way this oil can be used. Also, when hydrocarbon fuels are used in power plants that operate in a high-renewable electricity system at low average load factors the cost of abatement using power plant CCs can increase significantly. Ultimately this means that power plant CCS loses its cost advantage when compared with DAC plants capturing the same amount of CO2 over an extended period of time that are able to choose to operate all of the time.

Getting to zero, or negative, global emissions is becoming accepted as the challenge the world must overcome. This paper will demonstrate that delivering carbon dioxide removal technologies beyond BECCS is key to researchers and industry helping to deliver a successful response to this challenge.

O-3307-02

The use of carbon capture and storage in mitigation scenarios – an integrated assessment modelling perspective

D. Van Vuuren (1) ; E. Kriegler (2) ; K. Riahi (3) ; M. Tavoni (4) ; B. Koebl (5)

(1) PBL Netherlands Environment Agency, PBL, Climate, air pollution and energy, Bilthoven, Netherlands; (2) Potsdam Institute for Climate Impact Research, Potsdam, Germany; (3) International Institute for Applied Systems Analysis, Energy Program, Laxenburg, Lower Austria, Austria; (4) Fondazione Eni Enrico Mattei, Climate change and sustainable development programme, Milan, Italy; (5) Utrecht University, Utrecht, Netherlands

Carbon capture and storage (CCS) plays an important role in the model-based assessment of carbon dioxide emissions and also to optimise the use of global storage resources.

O-3307-01 (part2)
Assured capacity for geological storage of carbon dioxide

C. Vincent (1); M. Bentham (1); A. Liebscher (2); F. May (3); I. Akervoll (4); G. Falus (5); M. Vellico (6); M. Car (7); R. Stead (8); G. Pickup (9); D. Fernandez Poulussen (10); C. Savara (11); J. Alcoverro (12); C. Marinho (13); M. K. Al-Ghurair (14); P. Scott (15); C. Pinto (16); C. Vincent (1); M. Bentham (1); A. Liebscher (2); F. May (3); I. Akervoll (4); G. Falus (5); M. Vellico (6); M. Car (7); R. Stead (8); G. Pickup (9); D. Fernandez Poulussen (10); C. Savara (11); J. Alcoverro (12); C. Marinho (13); M. K. Al-Ghurair (14); P. Scott (15); C. Pinto (16)

This presentation will consider the latest scientific developments in two key areas for carbon dioxide (CO2) storage: how can sufficient and accessible CO2 storage capacity be assured prior to any investment decision for a large-scale CO2 storage (CCS) project? How can CO2 storage be implemented in a manner that is safe for humans and the environment? Assured geological storage capacity that is accessible on the required timescale is a key ingredient to enabling a positive retrofit decision. Decision; storage capacity is fundamental to the success of a CCS project. There are a number of recognized methods for estimating storage capacity, ranging from simple volumetric calculations to flow models. Each of these has advantages and disadvantages in terms of accuracy, data requirements and cost. Typically, accuracy of capacity estimates increases throughout the project from screening through geological characterization to site development and operation as more data becomes available. Any uncertainties in estimated storage capacities need to be communicated effectively to stakeholders. Data is one of the key issues in assuring storage capacity; the more data defining reservoir characteristics that are available, the more accurate the assessment of storage capacity. Strategies for optimizing the use of available data or for assessing the capacity are being developed and will be presented during this session. Assured capacity also has a regulatory and financial dependency; the cost for accessing the storage capacity needs to be affordable (e.g. with a relatively small number of injectors and such that the transport distance is not excessive) and storage needs to be permitted by regulations. Flexible storage solutions also raise interesting regulatory issues, for example, how will back-up be permitted? Strategies for CCS is required, assessing the national and international energy landscape and considering how to satisfy the requirements of society for affordable, dependable and sustainable energy sources with low greenhouse gas emissions. Strategic planning for geological storage of CO2 is also required to ensure the most efficient use of the subsurface. Early demonstration projects have highlighted the need to allocate sufficient time upfront for thorough geological characterization such that storage sites are available when needed; geological assessment of the potential sites needs to be conducted during the early phases of the project and this in turn needs to be built on early, strategic, national assessments. Ensuring that CO2 storage is carried out in a safe manner requires actions at all stages of the storage lifecycle from thorough pre-injection risk-led geological site characterization to effective monitoring, measurement and verification (MMV) of the site during injection to understanding of long term storage behavior and management of CO2 leakage. Models of the storage site are iteratively updated as new data and new techniques become available. Thorough site characterization includes testing the reservoir and seal properties (e.g. the threshold capillary entry pressure) for CO2 to enter the cap-rock needs to be determined. Best practice recommendations on understanding how risks to storage site security can be mitigated have been produced by recent projects. Demonstrating the site is behaving as expected through MMV is key to ensuring the CO2 storage site is safe.
is found more economical to develop under assumed costs and technological potentials. However, our study does not rely on assumptions about technologies and costs (but on the assumed mitigation potential). Another major difference with studies using IAMs is that ours rely on state-of-the-art Earth system models. Despite the difficulty of having to set some drivers exogenously, it allows a comprehensive assessment of the uncertainty related to the future response of the carbon-climate system. Here, we show that uncertainty can be greater than the results between two different mitigation floor assumptions. It emphasizes that the uncertainty surrounding any policy decision related to negative emissions primarily comes from our lack of understanding of the future behavior of the Earth system.

To conclude, we find that negative emissions are required at significant levels (i.e. > 1 GtC/yr) even for very aggressive mitigation floors. Given that negative emission technologies are still at an early stage of development, this pleads in favor of developing (financial) mechanisms to put them on a technological learning trajectory. But then, in all but the most optimistic cases, we also find negative emission requirements that have not yet been shown to be achievable: be it the flow of removal or the storage capacity. Following others, this study suggests that negative emissions alone are unlikely to be the panacea that will limit global warming below 2°C, and that conventional mitigation should remain a significant part of any climate policy aiming at this target.

P-3307-02
Negative emissions - interactions with other mitigation options
K. Kraxner (1); S. Fuss (2); P. Havlik (1); A. Mosnier, (1); S. Leduc, (1); P. Yowargana, (1)
(1) International Institute for Applied Systems Analysis (IIASA), Ecosystem Services and Management Program (ESM), Laxenburg, Austria; (2) Mercator Research Institute on Global Commons and Climate Change (MCC), Resources and International Trade, Berlin, Germany

Many scenarios in IPCC’s recent Assessment Report (AR5) find that there is a need for negative emissions in order to stabilize at concentration levels consistent with 2°C and 1.5°C global warming. This mainly refers to present technology assumptions largely covered by combining bioenergy with carbon capture and storage (BECCS). One major concern is that high feedstock potentials are supposed to be located in forests of the southern hemisphere, i.e. in the tropics, which is where at the same time forests are most vulnerable to deforestation. Consequently, a land-based mitigation option such as large-scale bioenergy production (w/o CCs) will interfere with options that are popular for their large co-benefits such as reduced emissions from deforestation and degradation (REDD+). Thus, this study uses a multi-scale bottom-up modeling approach (using an integrated land use model coupled with a global forestry model), this study aims to identify and quantify possible tradeoffs (i.e. land use-based mitigation options compete for the same land) and synergies (i.e. both options provide incentives to keep an intact and sustainably managed forest) between REDD+ and BECCS. The global results elicit the system interactions that have so far not necessarily shed much light on the situation on the ground. Thus, a regional analysis will be carried out, zooming into Indonesia as an important tropical basin that is assessed with respect to REDD+ and BECCS interactions. Indonesia has been chosen as a pilot region for REDD+BECCS because it looks back at decades of heavy deforestation, has established a strong palm oil sector and its remaining forests face high pressure from agriculture and a relatively developed infrastructure network. However, the difficulty of avoiding deforestation can have many implications for the establishment of sustainable bioenergy. It is therefore imperative to assess REDD+ and BECCS strategies in the future for achieving optimal mitigation potentials.

P-3307-03
Incentives for the Research, Development and Deployment of Greenhouse Gas Removal Techniques
T. Kruger (1)
(1) University of Oxford, Oxford, United Kingdom

Climate models that achieve the policy objective of limiting warming to less than 2°C do so by assuming not only extremely fast reductions in emissions, but also the deployment of technologies that remove greenhouse gases from the atmosphere at a massive scale. Yet there is a need to validate whether options like Bioenergy with Carbon Capture and Storage (BECCS) can be deployed at the scale implied.

This presentation will address the issue of the incentives required for researching, developing and deploying BECCS. It will examine the current costs of such options and explore how the deployment of these technologies could influence the overall global carbon price.

P-3307-04
Negative emissions in sustainable transition: Which role for bioenergies and CCs?
A. Laude-Depeyaz (1); X. Galéïgue (2)
(1) Université de Reims Champagne-Ardenne, Laboratoire REGARDS, Reims, France; (2) Université d’Orléans, Laboratoire d’économie d’orléans, Orléans, France

Carbon Capture and Storage (CCS) is a technology that aims to capture CO2 coming from static emitters such as coal-fired electric plants, then to transport it by pipelines until a geological reservoir (e.g. saline aquifers), where the CO2 is stored definitively. It is then an “end-of-pipe” technology, so it avoids to release pollution in the environment, but does not change the production process itself, contrary to renewable energies or bioenergy with Carbon Capture & Storage (BECCS) which needs additional energy – named energy penalty – and could reinforce the current technological lock-in in fossil energy. However, CCS could also allow a rapid decline of emissions on existing production facilities by the end of the century, when alternatives (such as renewable energies) will be fully deployed. In this case, the current sociotechnical regime based on fossil energies could be maintained for a while.

BECCS (Bioenergy and Carbon Capture & Storage) is a CCS niche that adds a CCS process on a bioenergy production unit. Industrial sectors such as biofuels, electric generation from biomass (or coal and biomass) or paper production are concerned. BECCS could change our point of view on the CCS role into the sustainable transition, as it could provide negative emissions which means that more GHG emissions are avoided than emitted during a production process. Instead of being released into the atmosphere during biomass transformation, carbon is definitively stored in a geological reservoir where it is assumed nearly carbon neutral, BECCS should effectively lead to negative emissions. This has been checked in a few cases in the academic literature (IAE GHG, 2009; Laude et al., 2011). In addition, a synergy between BECCS and geothermal energy recovery has been recently explored in the CO2-DISOLED project (Kervénan, Bedeile, & Neil, 2013). This process is adapted to small or medium emitters, like BECCS emitters are in most cases. It could reduce significantly the energy penalty due to CCS.

The aim of this paper is then to investigate the specific role of BECCS into the sustainable transition, and more precisely its impact on its timing. This issue has been discussed mainly through Integrated Assessment Models (IAM), which allow us to simulate and the evolution of the worldwide energy system under climate constraint until the end of the century. IAM modeling is one of the main tools used by IPCC for its forecasts and recommendations. It is then clear that BECCS could be key technologies to keep temperature increase below 2°C, especially if worldwide actions are delayed.

We use here a different point of view to deal with this issue: the Multi-Level Perspective (MLP). This conceptual framework analyses transition as a mutation process from one sociotechnical regime to another, under the pressure of macro-level forces (named the landscape) and the emergence of market niches that could provide the basis of the new regime (Geels & Schot, 2007). Here, climate change could be seen as a macro pressure (with economic and social aspects), that requires a deep change of the global energy system, i.e. the socio-technical regime. It is important to point out that both CCS and BECCS remain technological solutions, even if they require policy incentives and social acceptance. According to the
The Korean government has implemented energy policies such as RPS and ETS to raise the share of renewable energy sources since 2012. Among the renewable sources, carbon-neutral biomass, particularly solid fuel, is immediately applicable in coal-fired power plants, so a number of approaches to utilize bio-fuel by co-combustion with coal have been investigated. Hybrid Coal by Korea Institute of Energy Research (KIER) (2013) is a novel fuel for existing coal-fired power plants to cope with implementation of RPS, and we have published several articles related to the diversification of biomass to secure its feasibility. Many hydrophilic and hydrophobic bioliquids such as glycerol, bio-oils, and oil residues have been applied to saccharide substitutable substances, however, crucial limitations of each bioliquid were found. For examples, glycerol having hydrophilic property is eligible to be impregnated in coal pores, which is primarily derived from ash, but moisture readsoption cannot be inhibited since Hybrid Coal with bio-fuel (bio-ethanol process) derived from Non-edible Resources and its Process.

Development of Hybrid Coal with Bio-fuel Derived from Non-edible Resources and its Process

Sj. Park (1); J.S. Bae (1); YJ. Lee (1); JH. Park (1); JG. Kim (2); JH. Park (3); YC. Choi (1)

(1) Korea Institute of Energy Research, Clean Fuel Laboratory, Daejeon, Republic of Korea; (2) Korea Institute of Energy Research, Energy saving laboratory, Daejeon, Republic of Korea; (3) Dongwon Engineering, Ceo, Sihueng, Republic of Korea

The Korean government has implemented energy policies such as RPS and ETS to raise the share of renewable energy sources since 2012. Among the renewable sources, carbon-neutral biomass, particularly solid fuel, is immediately applicable in coal-fired power plants, so a number of approaches to utilize bio-fuel by co-combustion with coal have been investigated. Hybrid Coal by Korea Institute of Energy Research (KIER) (2013) is a novel fuel for existing coal-fired power plants to cope with implementation of RPS, and we have published several articles related to the diversification of biomass to secure its feasibility. Many hydrophilic and hydrophobic bioliquids such as glycerol, bio-oils, and oil residues have been applied to saccharide substitutable substances, however, crucial limitations of each bioliquid were found. For examples, glycerol having hydrophilic property is eligible to be impregnated in coal pores, which is primarily derived from ash, but moisture readsoption cannot be inhibited since Hybrid Coal with bio-fuel (bio-ethanol process) derived from Non-edible Resources and its Process.

Can we bet on negative emissions to achieve the 2°C stabilization target even under strong carbon cycle feedbacks?

K. Tanaka (1); T. Yokohata (1); Y. Yamagata (1)

(1) National Institute for Environmental Studies (NIES), Tsukuba, Japan

Given the narrowing windows of opportunities to stay below 2°C, negative emission technologies such as Bioenergy with Carbon dioxide Capture and Storage (BioCCS) play an even more crucial role in meeting the 2°C stabilization target endorsed by the Cancun Agreement (Fuss et al. 2014). Negative emission technologies - if deployable at a sufficiently large scale during the second half of this century – would make the 2°C target more feasible in the midst of the slow political progress and current emissions unchecked for some time if stakeholders are in the process of converging to a platform to abate emissions globally. However, such technologies are currently at their infancy and their future penetrations may fall short of the scale required to stabilize the warming (Scott et al. 2013). Furthermore, the overshoot in the mid-century prior to a full realization of negative emissions would give rise to a risk because such a temporal but excessive warming above 2°C might amplify itself by strengthening climate–carbon cycle feedbacks, which are known to be positive albeit with large uncertainties (Friedlingstein et al. 2006). When one considers other carbon cycle feedbacks including those with permafrost thawing and wildfire, such a risk could be even higher. It has not been extensively assessed yet how carbon cycle feedbacks might play out during the overshoot in the context of negative emissions, while the literature on carbon cycle feedbacks has burgeoned in recent years.

This study explores how 2°C stabilization pathways, in particular those which undergo overshoot, can be influenced by carbon cycle feedbacks and asks their climatic and economic consequences. We compute 2°C stabilization emissions scenarios under a cost-effectiveness principle, in which the total abatement costs are minimized such that the global warming is capped at 2°C. We employ a multi-box–complexity model, the Aggregated Carbon Cycle, Atmosphere, Chemistry, and Climate model (ACC2) (Tanaka et al., 2013), which comprises a box model of the global carbon cycle, simple parameterizations of the atmospheric chemistry, and a land–ocean energy balance model. The total abatement costs are estimated from the Marginal Abatement Cost functions for CO2, CH4, N2O, and BC, which are derived from Azar (2013).

Our preliminary results show that, if carbon cycle feedbacks turn out to be stronger than what is known today, it would incur larger potential abatement costs to keep up with the 2°C stabilization goal. Our results also suggest that it would be less expensive in the long run to plan for a 2°C stabilization pathway by considering strong carbon cycle feedbacks because it would cost more if we correct the emission pathway in the mid-century to adjust for unexpectedly large carbon cycle feedbacks during overshoot. Furthermore, our tentative results point to a key policy message: do not rely on negative emissions to achieve the 2°C target. It would make more sense to gear climate mitigation actions toward the stabilization target without betting on negative emissions because negative emissions might create large overshoot in case of strong feedbacks. Our simple approach illuminates a need for investigating this issue further by using a range of models including coupled Earth System Model (ESM)–Integrated Assessment Models (IAMs) to serve for the framework to be agreed upon in COP21 and maintained beyond.

References


Developments, opportunities and challenges for Bio-CCS in order to achieve negative emissions

S. Van Der Gijp (1)

(1) TNO, Sustainable Geo-Energy, Utrecht, Netherlands

Carbon Capture and Storage (CCS) is the only way to decarbonize fossil fuel. Large scale, full-scale demonstration projects such as the one in Boundary Dam Canada prove that this is an effective technology. A
similar technological approach can be taken in the cases of geothermal production and other biofuel applications, all of which can contribute significantly to a more sustainable energy mix, increased security of supply and a reduction of CO2 emissions. Both combustion and gasification routes to biomass conversion can be equipped with CCS which will result in most cases in a negative CO2 footprint.

First generation biofuels have some crucial limitations. By applying a thermochemical treatment process those limitations can be largely reduced. Typical thermochemical routes include pyrolysis, gasification, torrefaction and biochemical treatments. The products obtained are in most cases a combustible gas, solid char and CO2. The options for electricity and the scale of emissions generated reflect the biomass type and conversion route. Currently the main focus is to improve operational performance such as: efficiency, power flexibility and a (further) reduction of the emissions.

Large scale biomass combustion is mainly developed for the power companies, as a substitution for coal. Also standalone 250MWe CHP based on biomass pellets has been scrutinized by those companies. So far co-feeding of biomass in coal fired power station has been successfully accomplished at a level of 10–20% weight bases. Biomass polygeneration is based on partial oxidation (indirect gasification). The resulting syngas can be used as a raw material for the production of special chemical products or the production of hydrogen. The syngas can also be used to generate electricity and heat.

The integration with CCS brings with it specific challenges. Clever process integration is required as well as understanding the specific functional requirements. The use of Biomass required specific process conditions and material properties. In addition the use creates new types of impurities in the process and flue gas that:

- causes an increase corrosion (which in its turn affect amongst others the warrantee of the power plant);
- change the generic grid code requirements and more local grid requirements regarding ancillary services (power flexibility);
- have an effect on the requirements of the CO2 capture solvent;
- have a severe impact on the economics and
- finally the different operation modes compared to traditional fossil fuel large scale power plants has an implication on the downstream CO2 infrastructure, transport, use and storage.

The EERA joined program on CCS serves as platform to share the outcomes of research of the leading research entities in Europe and their program leads the way in the future joined development of Bio-CCS.

P-3307-08

From scenarios to reality: key issues with upscaling BECCS

N. Vaughan (1); C. Gough (2)

(1) University of East Anglia, Tyndall Centre for Climate Change Research, Norwich, United Kingdom; (2) University of Manchester, Tyndall Centre for climate change research, Manchester, United Kingdom

Substantial amounts of biomass energy with carbon capture and storage (BECCS) are used in the majority of emissions scenarios directed at limiting climate change to 2°C. The feasibility of these scenarios is an important concern for climate policy. We used an expert elicitation methodology to explore the key explicit and implicit assumptions that underlie these scenarios’ use of BECCS to deliver so-called negative emissions. The process highlighted key interlinked issues surrounding land availability, land use and land policy, timing of technology and infrastructure developments; and policy incentives, verification and social acceptability. Whilst there was agreement over the potential for BECCS to remove CO2 from the atmosphere and produce energy, claims to its capacity are potentially being over-relied upon and overstretched under the policy pressure to generate emissions scenarios that meet a 2°C limit.

3308 - Fiscal Reform

K-3308-01

A balance of ‘bottom-up’ and ‘top-down’ in linking climate policies

T. Sterner (1)

(1) Univ of Gothenburg, Dept of economics, 40530 Gothenburg, Sweden

‘Top–down’ climate negotiations embodied by the Kyoto Protocol have all but stalled, chiefly due to disagreements over targets and objections to financial transfers. To avoid those problems, many have shifted their focus to ‘bottom-up’ climate policies such as regional carbon markets. This approach is appealing, but we identify four obstacles to successful linkage: different levels of ambition; competing domestic policy objectives; objection to financial transfers; and the lack of regulatory coordination. Even with a more decentralized approach, overcoming the ‘global warming gridlock’ of the intergovernmental negotiations will require close international coordination. We demonstrate how a balance of ‘bottom-up’ and ‘top-down’ elements can create a path toward an effective global climate architecture.

K-3308-02

Do Chinese provinces successfully implement climate mitigation policies? A political economy approach

P. Motel-Combes (1) ; JL. Combes, (1) ; M. Fodha, (2) ; MF. Renard, (3) ; S. Zhang, (4)

(1) University of Auvergne, School of Economics – CERDI, Clermont-Ferrand, France; (2) University of Paris 1 Pantheon Sorbonne, Pse, Paris, France; (3) University of Auvergne, School of economics – c erdi – idrc, Clermont-Ferrand, France; (4) Peking University, College of environmental sciences and engineering, Peking, China

China is expected to be a major actor in the design of a new global climate architecture. Its non-participation could lead to a substantial increase in GHGs concentrations by the end of 21st century (Paltsev et al. 2012). China has already managed to cut CO2 emissions in several energy intensive industries and is now endowed with good technological and scientific capacities (Rock et al. 2013). The central government has fostered the implementation of environmental policies which are now a priority of the new Chinese growth model. It has been however recognized that China’s climate governance can further be improved regarding the coordination of national and provincial levels (Richerzhagen & Scholz 2008). This paper precisely intends to add to the debate between top–down and bottom–up approaches of climate mitigation policies in the context of China.

Indeed, the efficiency of climate policies in China is challenged by strong spatial i.e. provincial disparities. Provincial environmental characteristics are very different considering climate, geography, population densities, as well as urbanization and for instance, there is a very large diversity of energy intensity between provinces. The geographical distribution of China’s energy intensity exhibits a characteristic of progressive increases from the eastern coastal provinces to the western provinces (Yu 2012). One of the major characteristics of China is its decentralized organization and the strong power devoted to provincial governments. The leading officials have mainly focused on economic growth targets (Combes, Renard, Tapsoba, 2015) but environmental objectives are written in their responsibility contracts for few years. Local leaders sign individual responsibility contracts that embed energy or emission reduction requirements for their localities. The central government gives priorities at the national level and then assigns specific targets for the different levels (Kostka 2014).

This paper contributes to the understanding of provincial
climate mitigation policies and its aim is twofold. First an obvious environmental impact of climate change. Second, an econometric analysis model to estimate the impacts of climate change. The model is calibrated at the global level and is applied to estimate the impacts of climate change in various countries. The model is used to evaluate the potential for achieving the Paris Agreement goals.

A public finance perspective on climate policy: Six interactions that may enhance welfare

L. Mattauch (1); J. Siegemier (1), M. Franks (2); D. Klenert (2); A. Schultes (2); O. Edenhofer (3)

Climate change economics mostly neglects sizeable interactions of carbon pricing with other fiscal policy instruments. As a result, public finance typically overlooks the effects of future decarbonization efforts when devising instruments for the major goals of fiscal policy. We argue that such a compartmentalisation is undesirable: policy design requires an account of such interdependencies that may enhance welfare and change the distribution of mitigation costs within and across generations. This claim is substantiated by analyzing six interactions between climate policy and public finance that are insufficiently explored in current research: (i) reduced tax competition in an open economy, (ii) portfolio effects induced through climate change, (iii) restructuring public spending, (iv) revenue recycling and revenue basing, (v) intergenerational equity through appropriate revenue recycling and (vi) intergenerational Pareto-improvements through intertemporal transfers. We thereby structure the hetero-taxation and intergenerational effects of carbon taxes and other climate change mitigation and public finance and show that jointly considering carbon pricing and fiscal policy is legitimate and mandatory for sound policy appraisal.

Environmental Tax Reform and Heterogeneous Labor Markets: Can the Trade-Off between Environmental Quality, Efficiency and Income Distribution be Avoided?

M. Chiroleu-Assouline (1); D. Aubert (2)

This paper investigates the distributional and efficiency consequences of an environmental tax reform, when the revenue of the green tax is recycled by a variation of labor tax rates. We build a general equilibrium model with heterogeneous imperfect labor markets, pollution consumption externalities, and where poor households spend a relatively more on polluting goods than rich households (Stone–Geary preferences). We characterize the necessary conditions for the obtainment of the environmental and welfare dividends and we analyze the distributional properties of the green tax. We show that even in the case where the reform appears to be regressive, the gains from the double dividend can be made Pareto improving by using a redistributive non-linear income tax if redistribution is initially too large. The measure of a non-linear income tax acts on unemployment and can moderate the trade-off between equity and efficiency.

A Carbon tax and the Risk of Inequity

E. Combet (1)

This paper aims at clearing up some misunderstandings about the social impacts of carbon taxes that proved to be a decisive topic for current macroeconomic and public debates. It highlights the gap between the cost of a carbon tax reform as it is spontaneously perceived by the taxpayers and the reality of its ultimate consequences. The real impact of carbon taxes on household’s poverty and inequality is not mechanically determined by the initial burden of energy on consumption budgets and by the capacity of households to alleviate it, but also depends on the use made of the tax proceeds and its general macroeconomic impacts. The comparison of five tax-recycling schemes highlights the existence of trade-offs between maximizing total consumption, reducing unemployment, maximizing the consumption of the low-income classes and reducing income inequality.
corresponding long-term projections (Chateau et al., 2014). All the energy policies included in the Current Policy Scenario of the World Energy Outlook 2013 (IEA, 2013) are considered except the reforms to the consumers’ energy subsidies that remain at their 2011 levels. In the policy scenario, we assume that between 2012 and 2020, Indonesia unilaterally realises a gradual phase out of electricity and fossil fuel subsidies for households and firms. The scenarios differ by the budget-neutral compensating scheme for households they assume: cash transfers, subsidies on food products, and labour income support. An additional policy scenario envisions a global multilateral subsidy phase out and a cash transfers compensating scheme.

All the scenarios give way to positive impacts on GDP at the 2020 horizon (+0.4% to +0.7% in 2020 with respect to the baseline) due to a decrease in the deadweight loss associated with the subsidies and also, in some scenarios, to higher savings and investment. The cash transfer scenario (both unilateral and multilateral) determines the highest GDP outcome. The gains in terms of Equivalent Variation are even higher due to trade improvements consequent to the reform, and range between 0.8% and 1.4% in 2020. The distributive direct effect of fuel price increase is regressive for households. The effects through labour and non-labour incomes are more or less distribution neutral. However, the redistribution schemes can make the total effect of the reform progressive and pro-poor. The cash transfer scenario is the most progressive among the scenarios investigated. The budget redistribution using food subsidies is less progressive than with cash transfers. Transfers proportional to labour income, as used in the labour support scenario, are regressive because the incomes from formal labour represent a higher proportion of total incomes for high-income households than for low-income households. The reform outcomes are also heterogeneous across rural and urban areas: the cash transfer and the food subsidy scenarios are more beneficial to rural than to urban households due to the lower share of energy expenditures in rural areas. The labour support scenario, in contrast, is less beneficial to the rural households, because of the greater importance of the informal sector in these areas.

The phase out of energy consumption subsidies contributes to reduce in energy-related CO2 emissions (between −10% and −12%) and GHG emissions (between −7.3% and −8.3%) in 2020 compared with the baseline. The emission reduction is mainly driven by a decrease of household energy consumption.

**3308-POSTER PRESENTATIONS**

**P-3308-01**

Optimal Environmental Taxation with Capital Mobility

G. Schwerhoff (1) ; M. Franks, (1)
(1) Potsdam Institute for Climate Impact Research (PIK), Potsdam, Germany

Climate policy exemptions for energy intensive sectors are often justified with distributional concerns. One concern is that households employed in energy intensive sectors might be affected disproportionally due to capital mobility. We find that when workers cannot move freely between sectors, a uniform carbon tax causes more inequality between the sectors when capital is mobile than when it is not. Since households benefit more directly from sector-specific labor taxes, than from carbon tax exemptions, the former are more effective in reducing the distributional wedge caused by capital mobility. In addition, we find that the differential effect of capital mobility depends on the government’s degree of inequality aversion: Redistribution is more expensive when capital is mobile, so that highly inequality averse governments might even be better off without capital mobility.

How should a government take capital mobility into account when designing climate policy? There is a strong concern that climate policy affects energy intensive sectors disproportionately when capital is mobile. This motivates policy exemptions for these sectors. Recent papers considering exemptions usually consider one representative household. They find that exemptions are not optimal and conclude that carbon taxes should be uniform across sectors. In this paper, we consider a strongly inequality averse government as a means of addressing the sector-specific distributional effects created by the interaction of climate policy and capital mobility.

We build a model with two sectors of different energy intensity. To reflect the distributional concern we assume sectoral rigidity in labor mobility. The government maximizes a social welfare function which aggregates utility of the households working in the two sectors. The environmental objective is to reduce domestic carbon emissions, motivated for example by the objective to fulfil a carbon reduction target. We then compare the effect of environmental policy with and without capital mobility. We find that indeed climate policy introduces a bigger difference in inequality of the households employed in the two sectors when capital is mobile. Based on this we determine the optimal policy package for reconciling distributional and environmental objectives. We find three major results. The first result is that sector specific labor taxes are the most suitable instrument to redistribute among the sectors. Sector-specific carbon taxes can indeed be justified, but the difference should be very small. In optimum, redistribution between sectors is mainly achieved through relatively large differences in labor taxes. When labor taxes are optimally differentiated between sectors, the difference between utility of the households employed in the different sectors is much smaller than in the case where labor taxes are constrained to be uniform.

The second result is that the reaction of the government depends strongly on its inequality aversion. A utilitarian government achieves a higher welfare under capital mobility since it benefits from the gains of (capital) trade. A strongly inequality averse government faces high cost of countering the inequality increasing effect of climate policy under capital mobility. The cost of redistribution might be so high that it could even be better off without capital mobility.

The third result is that climate policy creates a greater difference between carbon and labor taxes when capital mobility than in autarky. The government’s ability to counter this shift through labor tax cuts is weakened through capital mobility since the reduced demand for pollution means that carbon tax revenues are lower under capital mobility than in autarky.
Development Research Centre**.

While recent reviews (IPCC, 2014) have identified a low evidence base in this area, the last few years have seen a growing number of national initiatives and risk sector specific studies. Over 500 relevant studies have been identified, and a growing number of these are in developing countries. The paper presents a review of this evidence base, focusing on estimates and insights for least developed and middle income countries. It starts with a mapping of studies, both geographically and by risk. This shows the coverage of adaptation costs and benefits has increased when compared to previous reviews. The geographical coverage now includes Africa, South and Central America and Asia, though there remain some important regional gaps. The coverage of risks has also increased: there is a very large literature on coastal zone adaptation, increasing studies on water management, floods and agriculture. Major gaps remain, however, for ecosystems and business/industry.

The paper then summarises a detailed review of this evidence base and draws some policy lessons, using examples. From a policy perspective, there are now three distinct set of studies, using different methods. The first uses scenario-based impact assessment (I-A) and focuses on technical adaptation. The second uses investment and financial flow analysis (IFF) and considers likely make-ups for adaptation. The final use the more recent focus on iterative risk management, low-regret options and decision making under uncertainty. The outputs of these approaches are very different in terms of framing and the importance of different adaptation options. They also produce very different estimates of the costs (and benefits) of adaptation, which is of particular importance in relation to National Adaptation Plans and international climate finance. A key finding is that IFF studies indicate higher costs in the short-term, due to the consideration of the existing adaptation deficit, while policy orientated studies indicate higher adaptation costs in the medium- to-long term in relation to the impacts, costs, cross-sectoral/cross-cutting effects and the limits of adaptation. Further work is also needed to understand the transferability of existing estimates. A key priority is to further encourage the sharing of information and good practice.


The views expressed in this paper are the sole responsibility of the authors and do not necessarily reflect the views of the European Commission. The European Community is not liable for any use made of this information.

**Co-funding was provided by: i) UK DfID, as part of the project ‘Early Value-for-Money Adaptation: Delivering VFM Adaptation using Iterative Frameworks and Low-Regret Options’ – this project has been funded by UK aid from the UK government; however the views expressed do not necessarily reflect the UK government’s official policies: ii) IDRC as part of the project ‘The Economics of Adapted and Climate-Resilient Development’ – however the views expressed are entirely those of the study team and do not necessarily reflect the views of IDRAC.

K-3309-02

Climate change adaptation: linking policy and economics in OECD countries

M. Mullan (1); S. Buckle (1)
(1) OECD, Environment Directorate, Paris, France

This presentation will summarise the key findings of a forthcoming OECD publication on the Economics of Adaptation of OECD countries (as of end May 2015), including a survey of these countries. By drawing upon policy-makers’ experiences to date, this presentation will examine how economic analysis has informed policy development to date, and priority areas for further data gathering and tool development.

OECD countries are increasingly taking action to prepare for the effects of climate change. As of 2014, more than three-quarters of them have published, or are currently developing, national strategies for climate change adaptation. In preparing for climate change, countries are faced with the challenge of responding to a broad range of uncertain risks. The common element of their response is an emphasis on mainstreaming adaptation into government policies, with a focus upon capacity building. Based on the analysis in this paper, the following priorities emerge for economic development and improved tools for economic analysis:

- Reducing barriers to usage: Increasingly sophisticated approaches have been developed to account for uncertainty about climate impacts, often in the context of large infrastructure investments. However, countries show that mainstreaming requires integration with existing appraisal systems for decision-making, and “light touch” approaches that are proportionate to the scale of the decision at hand.
- Achieving sufficient breadth of coverage: The evidence base on costs and benefits has significantly improved in recent years, as sectoral and national coverage has increased. However, major gaps remain in sectoral coverage. For example, impacts on businesses and ecosystems remain poorly understood. Modelling of macroeconomic interactions remains at an early stage. More evidence is needed to develop coherent responses to a changing climate.
- Accounting for the distributional and normative dimension of climate change: Economic analysis provides an important input into the decision-making process, but it is also necessary to account for people’s perceptions of the risks from climate change. In short, this is because decision-makers have to respond to the risks from climate change frequently involve trade-offs between different values. In addition, the impacts of climate change will be felt most severely by the poor and the marginalised. Few studies based on OECD countries have accounted for these impacts to date.

K-3309-03

Global challenge and regional analysis – Germany’s vulnerability and adaptation to climate change

U. Lehr (1); T. Drosdowski, (1); A. Nieters, (1)
(1) Gesellschaft fuer Wirtschaftliche Strukturforschung, Institute for Economic Structures Research, Energy and Climate, Osnabrueck, Germany

Overview

Although climate change is a global challenge, the effects occur locally and differ by region. The large timespan and the globality of climate change often obscure rather than clarify the discussion. Germany is located in a moderate climate zone; nevertheless it is vulnerable to disruptions due to its economic dependence on high-tech production sites. The largest disturbances come from extreme weather events. Global warming not only changes the weather, it also changes the way we are used to model economic development and economic growth. Dealing with this calls for new ways to think about climate change adaptation, and adaptation of our models to be able to simulate climate change effects as well. A feasible adaptation strategy will be developed by local decision makers, and thus needs to assess regional impacts of climate change and the socio-economic effects resulting from changing climate conditions. This contribution is based on findings from a study within the German Framework Programme “Economics of Climate Change”.

Methods

The authors have applied an input-output-based macro econometric model, adjusting it to cope with the (1) challenges of damages from extreme weather events and (2) adaptation measures. Infrastructure damages, shifts from domestic production to imports, low levels of productivity due to heat waves, and adaptation measures
are some of the topics the paper deals with. Crude data is the largest challenge we have to cope with. Results are obtained by a comparison of three scenarios – one with and one without considering extreme weather events, and finally a third one allowing for adaptation measures. These results are presented in the values of macroeconomic variables, such as GDP, exports, investment and employment as well as sector specific variables. For instance employment on the level of different economic sectors and regions. The paper provides details for economic sectors and the total economy.

Conclusion
The research on the feasibility of the IO type macro econometric model for the analysis of extreme weather events and the implementation of adaptation measures are yet to be implemented. The empirical evidence on reaction equations in a time series based model to model extremes in the future.

Given that Germany is in a moderately affected region, the larger challenges for an open economy as the German, will lie in climate change along the international value chain. A German adaptation strategy must consider this.

Economic evaluation on the impact and cost effectiveness of climate change adaptation strategies in crop production systems (using Structural Ricardian and Decision model): Case of Northern Shewa, Ethiopia

N. Mekonnen(1)
(1) Ethiopian Economic Policy Reserarch Institute, Poverty and Agriculture and Development Division, Addis Ababa, Ethiopia

Introduction and problems: To respond to the possible impacts of climate change, smallholder farmers have been using different adaptation strategies. Some of the major adaptation strategies in the Woreda include use of improved variety/early maturing, use of disease tolerant crops, use of irrigation, increased use of fertilizer and soil and water conservation techniques, water harvesting, constructing flood control, building wind breaks etc (ibid). However, we hardly know about the economic impact of climate change adaptation strategies in smallholders many of the literatures. In addition, given the limited coping capacity and resource constraint to further make investment on different adaptation strategies, we know very little about cost effectiveness of climate adaptation strategies in smallholder’s crop production system. The significant part of literature on climate change adaption focus on the determinants of adaption strategies rather than the economic impact of adaption strategies and their cost effectiveness at farm level.

Objectives: The general objective of this study is to identify policy relevant issues about the impact and cost effectiveness of climate change adaptation strategies among smallholders and by way to contribute to climate resilient agricultural development. The specific objectives of the study are: 1) To assess the economic impact of climate change adaptation strategies in the selected study area 2) To conduct cost effectiveness analysis on climate change adaptation strategies in smallholder’s crop production system.

Methods: The data for the research was obtained from the survey of 3330 households in two districts of North Shewa Zone in 2014. The sample households were selected randomly. The sample size in each district was determined based on probability proportion to size. The districts included in the survey were Yaya Gullel, Hidha Abote and Derra districts. The specific study sites within the districts were 18 kebeles. A structured questionnaire was used to interview the farmers. In addition, the research employed review of secondary data at zonal level (climate data, agriculture production data etc).

Economic Models and result: A Decision support model and a structural Ricardian model were used to estimate the economic impact of climate change adaptation strategies on smallholders and the cost effectiveness of different adaptation strategies. Thus, a comparison was also made between different adaptation strategies practiced by smallholder farmers.

The econometric results of the analysis show that adaptation to climate change strategies in boosting food production and farm level income. In addition, the fact that the adaptation variable is positive and significant in the estimates of production model indicates that adoption of yield related adaptation strategies have vital importance in terms of ensuring food security for rural households. On the other hand, the cost effectiveness analysis (cost effectiveness ratio) using the decision support model show that while some adaptation strategies have low cost effectiveness, use of disease tolerant crops are economically preferred strategies others are not.

Recommendation:
• If the interest of the farmers lay on the achieving climate change at the least cost, then provision of rain water harvesting, river diversion, use of disease tolerant crops would be the preferred cost-savings strategy
• If the farmers objective focused on “averting climate change impact ”, then increasing the acceptance rate of the provision of improved crop varieties and fertilizer use “6% and 2% respectively” is a cost effective strategy. So that, a prefers the agricultural production reduction and a structural ricardian model were used to estimate the economic impact of climate change adaptation strategies and a structural ricardian model were used to estimate the economic impact of climate change adaptation strategies on smallholders and the cost effectiveness of different adaptation strategies. Thus, a comparison was also made between different adaptation strategies practiced by smallholder farmers.

Climate Change and China’s Agriculture: Impact and Adaptation

H. Jikun (1) ; J. Wang (1) ; X. Wei (1)
(1) Center for Chinese Agricultural Policy, Chinese Academy of Sciences, Beijing, China

China’s agricultural sector is expected to face challenges in the future mainly due to rising food demand and constraints of land and water, which will be worsened by impacts of climate change. Understanding the importance of adaptation to climate change on agriculture is critically important for climate change policy. Acknowledging the large number of studies on climate change in the literature, the overall goal of this paper is to provide additional evidence on the impacts of and adaptation to climate change on agriculture in China.

Both econometric analysis and general equilibrium modeling are applied to analyze the direct and indirect impacts of climate change. The direct impacts on major crop yields are empirically estimated using provincial data collected over the past three decades. The impacts of severe drought and flood from extreme weather events on grain production are estimated based on a large scale farm survey in 22 provinces. The impact of climate change on market price response is simulated using an integrated impact assessment model under different scenarios. We identified adaptation measures taken by local governments and communities, and farmers for reducing climate risk based on primary surveys that include 3330 households from 330 villages in 9 provinces, and assessed which are the major factors that facilitate farmers to implement these measures. We also assessed the effectiveness of different measures in reducing climate risk on crop production.

Econometric results show that the effects of temperature and precipitation on crop yields are statistically significant though they differ largely among crops. Increasing temperature has a negative impact on the yield of several major crops such as wheat, barley, rice, cotton, and sugarcane though it also has a moderate positive impact on maize and rapeseed yield. However, decreasing precipitation reduces the yields of most crops. The simulation results show that overall impact of climate change on agricultural production is negative, but much less so than the direct
Climate finance at scale: emerging opportunities?

K-3310-01
Climate finance at scale: Overview of issues

TE. Downing (1); H. Mcleod (2)
(1) Global Climate Adaptation Partnership, Oxford, United Kingdom; (2) KPMG, London, United Kingdom

Climate finance is essential to reducing climate risks, and is at the heart of the UNFCCC’s climate regime. Engagement with the private sector goes beyond the expectation of finance for public funds or protection against expected losses and damages. Transformation of climate resilience requires leadership in a range of private sector forms of investment and sustainability. Emerging examples of how research has informed improved access to climate finance address fundamental questions. How can research inform private sector investments in adaptation? What are the barriers limiting the scaling up of successful pilot interventions? How can adaptation plans of implementing entities be informed by research? What is the business proposition for private sector investment?

ORAL PRESENTATIONS

O-3310-02
Climate finance at scale: emerging opportunities?

R. Mechler (1); T. Schinko (2)

Climate finance at scale: emerging opportunities?

O-3310-03
Impact Investing and unlocking Private Sector finance for climate change adaptation in Sub-Saharan Africa

N. Thaven (1)
Private finance for adaptation: do private realities meet public ambitions?

P. Pauw (1)

(1) German Development Institute, DIE, Bonn, Germany

The private sector’s role in climate finance is increasingly subject to political and scientific debate. Yet there is poor empirical evidence of private finance for adaptation and its potential contribution to the industrialised countries’ mobilisation of USD 100 billion of annual climate finance from 2020 onwards to support developing countries to address climate change. Building on earlier research (e.g. on the private sector’s role in adaptation in NAPAs and Zambia’s agricultural sector), we will present a paper on an analysis of 101 case studies of private sector adaptation under the Private Sector Initiative (PSI) of the UNFCCC Nairobi work programme. The case studies are examined against ten ‘adaptation finance criteria’ that were distilled from UN climate negotiation outcomes.

Results show that private adaptation interventions complement public adaptation activities all over world, including in priority sectors in developing countries such as water and agriculture. Yet the ten adaptation finance criteria are not aligned. For instance, it is clear that current sources of public finance fall far short of the required resources, and that the private sector has a role to play in providing some of the required finance.

The private sector however has its own requirements for investment and many adaptation projects will not be able to respond to the return on investment, stage of development or scale requirements of investors. Cti PFAN, the Climate Technology Initiative’s Private Finance Advisory Network has shown its ability to raise private sector finance for climate change mitigation, having raised in the region of $600 million to date. It is now trying to replicate this success for adaptation, supported by IDRC, and at its last Investor Forum in Johannesburg in November 2014, was able to showcase adaptation projects from Africa which have the ability to respond to some of the demands of private sector finance, with projects from multiple sectors, including water, agriculture, real estate, tourism and microfinance, at various stages of development, and various scales. Twelve projects were showcased to investors, each of which represents both public and private goods, but with in-built social and environmental credentials.

There are trillions of dollars being invested annually by the private sector and the growing call for responsible investment is part of the stimulus for the growing sector of Impact Investing. Organizations such as “100% Impact,” have shown that pure impact investments have the potential to match the returns of conventional investments. Whether the investment community is aware of project categorization as mitigation, adaptation or just good development is a moot point.

The Impact Investment community represents a high potential source of private sector finance for supporting adaptation actions if the adaptation projects can demonstrate their ability to quantify their impact. The current CfP work is thus aligned with a research component, managed by the Frankfurt School, which, amongst other issues such as an assessment of the policy environments and risk analysis is also looking at the metrics of adaptation.

To secure some of these private sector funds for adaptation activities, the relationship between adaptation projects and the impact investment community needs to grow, and there are four key issues which the current CTI PFAN project aims to address to achieve this:

1. The development of a pipeline of investment grade projects;
2. The leveraging of public funds to generate investment tipping points and to create a market of these types of investments;
3. Mechanisms to bring these projects into view so that they become part of the available options for investment;
4. Developing metrics for assessing adaptation activities.

3310-POSTER PRESENTATIONS

P-3310-01

Missed Targets, Missed Opportunities! Lessons from tracking Adaptation Financing for Zambia

P. Mbozi (1)

(1) University of Zambia, Institute of Economic and Social Research, Lusaka, Zambia

Who funds and who benefits from climate change adaptation (CCA) funds in Zambia? This was main question that a study commissioned by the Zambia Climate Change Network wanted answered. The study set out to map, track and analyse both donor and government CCA funding, as part of the global Adaptation Finance Tracking Initiative (AFTI). The goal was to improve CSO advocacy for transparency, accountability, participation and ownership of CCA programming and financing for CCA and resilience in Zambia and help address identified institutional and structural constraints to the effective delivery of climate finance to intended beneficiary constituencies. The experience would be used strengthen tools to track and monitor adaptation and resilience finance flows from a multitude of sources down to the local level and for South-to-South learning. The study focused primarily on seven sectors which received CCA funds from donors either through the Civil Society Environment Fund (CSEF) or through bilateral agreements between a donor or donors and a particular NGO. The study notes that despite CCA funding is donor driven, with government contributing less than 1% of the total expenditure to the seven sectors; lack of prioritization for CCA; negligible and fluctuating funding; and, less CCA funds compared to non-CCA funds and actual disbursements is noted, including among donor finances. Lack of government policy on climate
change affects climate change financing, resulting in budget variations from year to year and lack of a budget line specifically for CCA especially for grass-root activities. Most funds go to upstream activities – salaries, workshops, etc. – and CCA is lumped together with environment and other CC projects such as adaptation, in the national budgets. This makes it difficult to track CCA funds and it explains why there are no visible CCA activities on the ground. The study also notes rigidity in budget lines to accommodate emerging issues, such as CCA and limited absorptive capacities among recipient sectors, resulting in variances between disbursed and utilized funds. The study found that stakeholders and ordinary people, especially at the local level, are not involved in any of the three key levels of the budget process: 1. Preparation of the budgets; 2. Monitoring expenditures from the allocated funds; and, 3. Reviewing the impact of the funded programmes, hence the apparent mismatch between what the government does and what the people see as their main priorities. Further, stakeholders and local communities lack civic education about the budget and its processes and about their right in the resource allocation. In demanding financial accountability and effective participation in tracking government expenditures. The study also established that the budgeting process and budgets themselves are too complicated for ordinary citizens, even professionals responsible for budgets at local level, to understand. Many people are often put off by the size of the Yellow Book and difficulties in accessing the financial and Auditor General’s reports. Further, tracking and budgeting for CCA funds is hampered by lack of knowledge of CCA funds coming into Zambia by heads and staff of government departments, stakeholders and local communities and their leaders. The study also notes lack of synergy and collaboration, especially at local level, among organizations, including CSOs that are involved in CCA in one way or the other. This weakens their capacity in advocacy. The study acknowledges the existence of various methods and tools of tracking finances for specific interventions. It recommends a cocktail of tools of tools. It recommends focusing advocacy on the accessibility of CCA financing through domestic resources, more social accountability, transparency and community and stakeholder ownership participation in allocations and disbursements.

3311 - Climate mitigation policies - learning, evaluating and comparing national experiences

O-3311-01
Climate Policies across Africa: Increasing Interactions and Building Resilience
A. Maupin (1)
(1) South African Institute of International Affairs SAIIA, Johannesburg, South Africa

In its quality of a worldwide well-attested phenomenon, climate change will spare no continent. This being said, Africa has started to host climate-related global conferences. Such as the New World Summit on Sustainable Development in Johannesburg in 2002 and the 17th Conference of the Parties (COP17) in Durban in 2011, both cities being located in South Africa. In addition, African climate-related bottom-up initiatives have played a growing role in climate negotiations, notably by shifting the climate change mindset from an environmental challenge to a development one. As a result of this more comprehensive view of climate change, numerous actions now speak to the increasing number of integrated public policies in different sectors and attempt to bridge the gap between policy development and implementation. However, few African countries have developed comprehensive climate-related policies. More often, these policies focus on responding to extreme events on one side and managing resources on the other. For example, after Mozambique was forced to appeal for international help to rescue its people during the 2000–2001 massive floods related to the passage of several cyclones, the National Centre of Disaster Management (NCC) was created with the task to evaluate, respond and adapt Mozambique to these changes. On a different note, recent provincial plans promulgated by the Democratic Republic of Congo (DRC) have considered the importance of including adaptation and mitigation strategies to fight climate change impacts and protect this country’s environment. In South Africa, the National Climate Change Response has been conceived as a process through which stakeholders’ comments and scientific inputs via dialogues. This diversity of responses reaffirms not only how diverse the national contexts (notably risks and priorities) are, but also how unique the stakeholders’ interactions and the locally-built initiatives have become to tackle climate change challenges. Against this background, this paper presentation aims to provide an overview of the numerous climate-related policies that exist across African countries in order to analyze the stakeholders’ responses to climate change. This, in turn, will contribute to develop and implement more interactive policies, which could be further scientific-and initiatives-informed at the national and regional level. Given the importance of natural resources for development and the expected global impacts of climate change on water, energy, forestry, among others, climate-related and resources-based policies would arguably become strategic components of state security. Interconnections between climate change and resources management policies also become evident in Africa when they demonstrate states’ growing interests in linking future adaptation and mitigation plans with environmental concerns across Africa.

O-3311-02
Policy Instruments to Overcome Energy Efficiency Barriers in Designated Buildings under Thailand’s Nationally Appropriate Mitigation Actions (NAMAs)
Y. Asayama (1) ; B. Limmeechokchai (2)
(1) National Institute for Environmental Studies, Tsukuba, Japan; (2) THAMMASAT University, Sirindhorn International Institute of Technology, Pathumthani, Thailand

Thailand pledged its Nationally Appropriate Mitigation Actions (NAMAs) at UNFCCC COP20 in Lima, Peru, following ongoing discussions since 2012. Improvement of energy efficiency in designated buildings is one of the main countermeasures under the proposed NAMA. Data collection on the actual energy consumption of the buildings plays a key role in determination of the scope of countermeasures as NAMAs and implementation of Measurement Reporting and Verification (MRV). However, the issue of how these countermeasures will be implemented in the context of the unsatisfactory progress of existing policy instruments, particularly the Building Energy Codes (BEC) and energy management reporting system as specified in the 2007 Energy Conservation Promotion (ECP) Act and the Energy Efficiency Development Plan (EEDP) over the period of 2011–2030 remains to be addressed. The objective of this study is to examine the potential of policy instruments and energy-saving measures to overcome the existing barriers. Firstly, the literature is reviewed, with discussion of theory-based policy instruments for building energy efficiency in order to analyze the situations and gaps in policy instruments adopted in Thailand. The means of enforcement and implementation of alternative policy options are also examined. The study also incorporates interviews with relevant stakeholders involved in the NAMA process as well as EEDP in order to consider the literature available on Thailand’s situation. Furthermore, good practices implemented in other countries were considered for their suitability for application in Thailand. The necessity of addressing legal and institutional barriers in order to overcome the information barriers was clearly evident in Thailand. The literature shows that regulatory measures have been implemented since 1995 under the ECP Act. However, these have only been implemented.
on an ad-hoc basis. In the case of existing buildings, there is no benchmark to identify electricity consumption involved in conducting the required energy management in each designated building. There are also limitations in the availability of information on technologies and technical information contribution to energy savings and operational management. The in-depth interviews indicated that BEC for the construction of new buildings and third-party energy audit have not as yet been implemented. The limitations in human resources and capacities to implement verification and monitoring of the submitted reports have prevented the consolidation of regulation measures as well as the revision of energy efficiency performance standards. Hence, this has given rise to a paucity of sufficient and credible data and made it difficult to achieve the understanding of the existing situation, future projections, and impact of policy instruments.

Results show that the targets of EEbD and Thailand’s NAMAs will not be effectively achieved without improvement in the means of achieving compliance levels in the existing institutions. Progress on this front will be achieved through improved awareness of energy efficiency and co-benefits of implementing the actions through the development of benchmarking and information disclosure for buildings’ energy performance, and providing tailor-made solutions. It is necessary to initiate process-oriented, interactive policy-making, with guarantees remaining on the ground in order to enhance the credibility of governmental decisions and activities, and to collect and accumulate reliable data and information for energy efficiency toward the achievement of NAMA objectives.

Climate policies : learning from a comparison of different national experiences

P. Mallaburn (1)

(1) Policy Climate Journal, Welwyn Garden City, United Kingdom

Peter Mallaburn will give an introductory speech to the session, questioning how a comparison between different national experiences of developing climate policies can be operated, and what are the challenges we face when trying to organise a learning process between these various experiences.

Price and Prejudice: The politics of carbon market establishment in Turkey

AC. Gundogan (1) ; E. Turhan (2)

(1) King’s College London, Geography, London, United Kingdom; (2) Istanbul Policy Center, Sabanci University, Istanbul, Turkey

Despite increasing number of studies on carbon tradings’ promises and self-contradictions, it has been continually presented as the most effective climate change mitigation option and has become a huge global business. On the other hand, governments’ endless support to the carbon markets has been criticised since the emission trading balloons exploded numerous times. Being an EU-accession country with no access to EU ETS (Emissions Trading Scheme) and an Annex-I country with no flexibility mechanisms under mechanism of Kyoto Protocol, Turkey is a latecomer to the game. While being a country whose greenhouse gas emissions increased by 13% between 1990-2013 showing the highest rate of change among OECD members, Turkey’s climate politics are increasingly drawn into market based climate policies particularly in the dawn of a new global climate agreement that is set to be signed in 2015. As a result of external pressure from institutions like World Bank and private sector driven processes, Turkey has started lay down limited policy and legislative groundwork in pursuit of setting up an emission trading system which the country is expected to be linked to the international carbon markets. However, implementation of the emission trading mechanism has never been widely discussed in Turkey hence making it a highly non-transparent process. Potential environmental and socio-economic impacts of the market-based instruments in the framework of combating climate change are being watered down by politicians, industrialists and technocrats while illusive promises of the carbon markets are presented as the centerpiece of Turkey’s position in the new climate regime. This paper critically analyzes the perceptions, promises and discourses of the emerging emission trading system in Turkey from a political ecology lens by scrutinizing different actors’ (including representatives of environmental justice movements, state bureaucrats, private sector and international organizations) statements. By doing this, this research aims go beyond dominant voices on carbon market establishment in Turkey, by revealing power relations, preferential treatment of some top-down policy options and the influence of multilateral finance organizations. Such critical approaches suggest that policy preference towards carbon markets vis-à-vis carbon tax in Turkey are not necessarily a rational process lack scientific substance as well as public buy-in.

Climate legislation in the UK: the Climate Change Act and the Committee on Climate Change

S. Smith (1)

(1) Committee on Climate Change, London, United Kingdom

The UK has traditionally been a progressive nation in calling for action on global warming. In 2008 it passed a Climate Change Act with strong backing from all the major political parties.

The Act set a target for national greenhouse emissions to be at least 80% below 1990 levels by 2050, created a system of 5-year carbon budgets to get there, and set a programme for adapting to climate change. It also created an independent Committee on Climate Change (CCC) to advise on these aims and monitor progress towards meeting them.

This talk will cover the Act, the role of the CCC and the various factors (such as climate science, economics and institutional circumstances) that informed the UK emission targets. It will show how the 2050 target is achievable, highlighting the key technologies likely to be needed and the cost involved. We will also see what policy progress has been made in the 7 years since the Act was passed and take a critical look at whether or not the UK is on track to meet the first few carbon budgets.
Bangladesh has made remarkable efforts in ‘strategies and plans’ to streamline regulatory and institutional settings as a pathway for adapting climate change impacts following existing policy acts. Bangladesh is the first example country for taking various initiatives for the adaptation. The adaptation is the key for survival, initiatives taken in different sectors of the government. One of the six pillars in the adaptation and Strategy Plan is ‘Low Carbon development’ that puts emphasis on energy efficiency, energy conservation and utilization of renewable energy as potential mitigation options (Bangladesh National Action Plan 2009). To adapt the climate impacts, Bangladesh developed Flood Action Plan (1988), the National Water Management Plan (2004), the Standing Orders on Disasters (2010), the ‘Bangladesh Climate Change Strategy and Action Plan’ (2009) and the ‘Bangladesh Climate Change Strategy and Action Plan’ (2009) to take necessary preparedness.

The Strategy and Plan is to strengthen adaptive capacity of the local communities and to foster innovation in climate change related technologies which would reduce poverty, enhance employment, ensure security of food, water, health, energy and socio-economic well being of all citizens of the country. Bangladesh has prepared a Road map towards formulating a comprehensive NAP with a view to taking the responsibility to the impacts of climate change by building adaptive capacity and resilience, flood and cyclone shelters.

Bangladesh Meteorological Department developed better early warning system for cyclone and other hazards using satellite data. The Flood Forecasting and Warning Centre is engaged to alert the vulnerable people about flood risk. Introduced climate tolerance (saline, drought, flood, rain-adapted) crop production. Bangladesh has established two innovative funds: Climate Change Trust Fund from the Government’s own budget with an initial capital of US$ 5 million Climate Change Resilience Fund (initial fund US$188 million) with the support of development partners. Recent disaster casualties and damages shows the successful reduction compared to previous events. Satellite images are most useful as first responses to disasters and post-disaster assessment. Satellite phones/mobiles/tv channels are useful for emergency warnings. The satellite technology creates new hope and inspirations for human lives.

P-3311-02
Forest management systems within rural communities of the north west region of Cameroon, strong strategic approaches for climate change in sub-saharan africa.aw.
awa (1)
(1) IMPACT CREATORS/ COMMUNITY DEVELOPMENT ALLIANCE GROUP; BAMENDA, Cameroon

In a bid to tackle some of the questions raised by climate change, this paper will discuss Sustainable Forest Management Systems in Rural Communities of the North West Region of Cameroon, strong strategic approaches for climate change in sub-saharan Africa.

Human actions on forest, such as uncontrollable harvesting of medicinal plants, felling of trees, farming, bush fires and local bee farming practices like generating smoke to drive away bees from a hive by burning fresh leaves of plants, provide negative effects on climate. This paper presents an analysis of the scientific evidence, indicating that negative influence on forest is affecting the climate in Cameroon. Sea levels are rising; rainfall has decreased by 11% in the last 40 years, which has greatly affected the forest. This paper identifies strategic approaches that are practiced in tackling forest management and climate change in Cameroon. Examples are: tree planting, renewable energy, water, other potential conservation land use systems, forests conservation methods and farming techniques, which influence climate change and the health of forest positively.

The concept of indigenous ecosystem and forest management systems used in this paper refers to a series of practices based on agreed rules, carried out by the local people, aiming at the sustained availability of products and services from trees, crops and forest through Sustainable Development for climate change. Local populations surrounding these forests understand the ecosystem of communities, taking an active role in preserving and protecting the forest, in order to ensure long term benefits and stop the ill effects of climate change in the society.

The paper concludes that this project is building these capacities in collaboration with the various stakeholders in the localities for a healthy conservation of forest and mitigating the effects of climate change. Forest management and monitoring plans are carried out using participatory methods and are designed to meet the needs of the communities and their families, which is the biggest challenge of implementing Sustainable Biodiversity and Climate change functions.

The political internalization process of climate issues in Brazil and China (1992-2012)
F. Barbi (1); LDC. Ferreira, (2)
(1) University of Campinas, Center for Environmental Studies and Research, Campinas, Sao Paulo, Brazil; (2) University of Campinas, Center for environmental studies and research, Campinas, Brazil

In terms of climate change responses, it is argued that governments are important actors that play a key role in the development of norms, institutions and appropriate modes of governance to address these changes at different levels and scales. This paper analyses the internalization process of the climate issue at the government level in Brazil and China. These two countries have been noted for their importance in the international arena and, above all, the importance of environmental factors in the rationalization of political processes. In terms of methodology, this analysis is based on three main points: i) Trajectory of greenhouse gases emissions in Brazil and China, in the period of 1992-2012. ii) Political and institutional structures mobilized to the climate issue, focusing on mitigation; iii) Political responses related to climate change, through a historical reconstruction of policies, plans, major programs and projects developed and implemented related to climate change mitigation. The starting point for this analysis is the year of 1992, more specifically the consequences of the United Nations Framework Convention on Climate Change, resulting from the United Nations Conference on Environment and Development, which marks the beginning of the involvement of both Brazil and China in international discussions and negotiations on climate change. The results of our analysis in in how climate-related emissions have fallen since 2008 and there has been a change in the profile of greenhouse gases emissions in the country. Land-use change and forestry sector has no longer been the most responsible for emissions since 2010. However, all other sectors have increased their emissions over the analyzed period. In the case of China, even with mitigation efforts undertaken, emissions have increased every year. However, the emission growth level has declined reflecting the country’s efforts in the installation of low carbon power generation and improvements in energy intensity. In Brazil, there are robust and consolidated political and institutional structures to address the climate issue, involving other segments of society such as the private sector, civil society and research institutions, among others. Regarding political and scientific framework, there was a significant increase in the number of studies and systematization of studies and reports, which can assist the design and implementation of policies related to the problem, and reduce the uncertainties related to climate change. China has also made some progress in this direction. The results show that, in Brazil, the climate issue internalization process is characterized by three phases: the first, marked by the establishment of advisory and institutional and scientific structures engaged with the issue. The second, stands out for greater understanding of this issue in the country. It is marked by the development of political and scientific research, and the increase in planning actions in the country. The construction of this agenda was fundamental in laying the foundations of the national policy on climate change. Finally, the third phase is marked by the development of climate policies and by strengthening the scientific agenda around the theme. The national policy agenda is focused on the implementation...
of sectoral plans, to meet the voluntary mitigation targets established by the National Climate Change Policy. In the Chinese case, the internalization process of the climate issue has two phases: the first, has more focus on combating air pollution, whereas the climate issue serves as a secondary goal. The second phase, is more proactive regarding concrete commitments on climate change, with the establishment of the National Climate Change Program and the National Leadership Panel on Climate Change. Both Japan and China still have challenges to be faced in relation to the set of problems that make up the environmental issue in a world characterized by global climate change. Environmental and climate concerns have difficulties to become political priorities in both countries. In any case, policy measures aimed at climate issue in these countries may lead to the reconfiguration of international negotiations about it.

P-3311-04

Agricultural biodiversity in climate change adaptation planning: An analysis of the National Adaptation Programmes of Action

A. Bedmar Villanueva (1); M. Halewood (1); NL López (1)

(1) Bioversity International, Roma, Italy

To guide climate adaptation policies and investments, the least developed countries (LDCs) have developed National Adaptation Programmes of Action (NAPAs). This study analyzes the extent to which agricultural biological diversity is included as part of national adaptation planning. The 50 NAPAs developed by LDCs to date. Lessons learned from the NAPA development process are potentially valuable to countries that will be developing NAPs in the years to come. Agricultural biodiversity (at genetic, interspecific and ecosystem levels) can contribute to the resilience of the agricultural systems faced with increasing climatic variability, thereby reducing farmers’ vulnerability. The paper presents a framework for analysis existing literature concerning climate change and adaptive capacity, agroecosystems’ vulnerability and resilience and the use of biological/genetic diversity in agricultural production, plant breeding, research and development. The study identified 48 activities included in the NAPAs that do (or at least could) increase biodiversity in agricultural production systems and/or in upstream research and development chains as part of strategies to adapt to climate change. These activities were clustered, first, by sectors (crops/forages, livestock, fisheries, forestry, agroforestry and natural resources) and then by biodiversity levels (genetic/intra-species, species and ecosystem). The analysis highlights that the exploitation and increase of agrobiodiversity is included in many of the NAPAs: 31% of all of the priority project proposals based on the NAPAs include some combination of the 48 agrobiodiversity-related activities. However, approaching the 11 countries that have established precedents/models for scaling up agrobiodiversity projects, pre-existing national policies related to agrobiodiversity and agrobiodiversity projects, pre-existing national policies that underscore the importance of agrobiodiversity, etc. On the other hand, the paper notes that 11 countries that included highest levels of reliance on agrobiodiversity are spread across 3 continents and have very different agrocultures and climate-related farmer vulnerabilities.

P-3311-05

Analysis of low carbon policies in the building sector

H. Beiija (1)

(1) environmental science, shanghai, China

Building sector accounts for a large percentage of the GHG emission. It is critical to raise appropriate low carbon policies both in developing and developed countries in the building sector. This study focuses on low carbon policies in building sector by conducting a comparison study between Japan and China so that different policy implications can be recognized for countries in different development stages. Two research questions are discussed, including how effective current low carbon policies are and what obstacles exist. Both stakeholder interviews and literature reviews based on Scopus database were undertaken.

In order to address these two issues, related policies are categorized into four groups: control and regulatory instruments; economic/market-based instruments; fiscal instruments; information and voluntary actions. Policy effect analysis identifies that low carbon policies in the building sector have promoted energy saving in both Japan and China. Especially, the innovative Cap and Trade Program in Japan has greatly enhanced the GHG emission reduction. Obstacles comparison reveals that Japan and China shared many obstacles including high transaction costs and lack of applicable methodology. But different countries also exist. For instance, the unstable political condition and the unexpected disasters accidents impede the Japanese government to initiate more innovative energy policies in Japan, while China is suffering from obstacles such as inefficient enforcement, and immature financial regulation system.

Based on the previous findings, common suggestions for overcoming these obstacles of low carbon policies in Japan and China are presented such as the establishment of baseline identification and emission accounting, innovative incentives, and more capacity building activities. Finally more specific suggestions for both Japan and China are also added by considering their own situations so that both countries can further improve their BES policies.

P-3311-06

Rethinking Climate Change Research in Zimbabwe

S. Bhatasara (1)

(1) University of Zimbabwe, Sociology, Harare, Zimbabwe

Climate change is arguably one of the most pressing challenges confronting Zimbabwe. As such, it has received considerable attention from a wide array of scholars. Certainly, very significant contributions have come from scholars who have deployed various models to establish trends in climate change as well as assess and predict its impacts particularly on agriculture. Paradoxically, even though climate change knowledge in the country continues to grow, questions on how climate change is framed, how impacts are derived using various quantitative methods and models and, even the language used in such studies have not been adequately analysed. These facets are critical particularly because how climate change is framed has important implications for adaptation in the country.

Following the above, this paper subjects various studies on climate change in Zimbabwe to rigorous critical analysis with the intention to demonstrate how climate change and its effects have been framed and the utility and pitfalls of such. The important question is, what and whose frames are being activated and hence strengthened and. what are the implications for adaptation? The paper argues that climate change knowledge and climate change need to be unpacked and reframed by deploying new and bold ontological and epistemological positions. This involves decolonizing and analyzing local narratives of climate change, for instance of local farmers, living on the frontiers of such changes, and also suggests that interpretive
Mainstreaming climate adaptation-mitigation measures at local level: rifling common institutional orbit in Nepal

D. Bishwokarma (1)
ForestAction Nepal, Research, Kathmandu, Nepal

Integration of climate mitigation and adaptation has now been becoming more powerful concern in climate change policy architecture to achieve synergistic outcomes. It has become more powerful concern in least developed countries (LDCs) including Nepal considering unavoidable risk of climate change but their high vulnerability. Since recent past, Nepal has been planning and implementing both adaptation and mitigation strategies considering the exclusion on planning and implementation, both adaptation and mitigation projects have chosen resourceful and independent local forestry institutions mostly community forest users groups (CFUGs) as an entry point to dispense project input at the grass root level. This article scrutinizes the potentiality of local forestry institutions to contribute to and integrate climate adaptation and mitigation. It further reviews implications of and lessons to achieve synchronized outcome from adaptation and mitigation measures from existing institutional arrangements in Nepal.

This paper is the outcome of two comparative case studies of CFUGs in Dolakha and Lamjung districts where mitigation and adaptation measures have been implemented. It mitigates the reducing emissions from deforestation and forests degradation (REDD+) and preparing community adaptation plan (CAPS) respectively. Four focus group discussions in the case study sites, four key informant interviews, existing climate change policy documents review, and literature review.

The research found that CFUGs have been contributing on both mitigation and adaptation through their services since before any external funds. Nonetheless, both quantity and quality of services have increased after implementing climate mitigation and adaptation projects through both government and non-governmental agencies. CFUGs have been chosen as an institutional unit to implement different mitigation measures including sustainable forests management, afforestation, and installation of smokeless stoves. The same institution has been preferred to implement adaptation measures including conserving drinking water, watershed management, and installation of early warning systems. The research further found the overlapping of activities such as installation of smokeless stove and afforestation to achieve both mitigation and adaptation objectives. CFUGs even have funded to implement both mitigation and adaptation measures. It signifies the functional aptitude of CFUGs to integrate mitigation and adaptation in practice. However, its implementation level since adaptation and mitigation projects are being designed and implemented separately by two different sectoral ministries. We found that the supportive and harmonious relationship of adaptation and mitigation at the community and central level mechanism has been encumbering the functional contribution of CFUGs. The contradictions between climate change policies have further been stimulating for the sectoral and segregated planning and implementation of adaptation and mitigation measures. Such contradictions have further affecting on mutual coordination at the policy level. Nepal is eluding an opportunity to utilize existing and voluntarily emerging forestry institution to integrate adaptation and mitigation due to such differential interferences at the central level. This paper suggests that Nepal has a unique opportunity to play a role in model of contribution to ongoing global debate to integrate climate mitigation and adaptation in LDCs by employing collaborative planning and implementation. The central level policy institution such as such national planning commission having directive authority to sectoral ministries should play a role for overall designing and planning mitigation and adaptation projects to ensure bottom-up mainstreaming, overcome mismatch at policy level, and acknowledge functional potentiality of CFUGs at local level.

Towards Adaptation: Advanced scientific knowledge to better prepare for climate change

V. Bourduas Crouhun (1); R. Siron (2); L. Leclerc (2)
(1) Ouranos, Vulnerabilities, Impacts and Adaptation, Montréal, Canada; (2) Ouranos, Project Coordinator, Montréal, Canada

To prepare for and cope with a changing climate, the Québec government created, in 2002, a research committee named climate change and adaptation; synthesis of knowledge on climate change in Québec. In 2004, the committee released an adaptation: synthesis of knowledge on climate change in Québec was the most thorough and up-to-date portrayal of what can be expected in the upcoming decades in the province. The synthesis is divided into three major chapters including climatic analyses and scenarios of change; vulnerabilities and impacts; and implementation of adaptation. This document helps answer questions such as, “What are the effects for Québec and what options exist to cope with the expected changes?” Elaborated through a collaborative process, it involved over 80 authors and advisers and covered an immense territory (over three times the area covered by France), exposing the reality of over 17 degrees of latitude and more than 22 degrees of longitude. Since this research covers a broad area of climate types and geographic regions, multiple results from this study could be applicable or transferable in other provinces of the country and even outside Canada.

The presentation submitted for this conference will explore a few highlights from this study including the following.

Since the 1950s, the average annual temperature in Québec increased by 1 to 3°C, depending on the region. It is anticipated that by mid-century the temperature could continue to rise by 2 to 4°C and, by the end of the century, by up to 4 to 7°C in the south and 5 to 10°C in the north. In addition, extreme weather events such as heavy rain and flooding are expected to occur more frequent and/or more intense with a warming climate. A sea level rise of 30 to 75 cm in the Gulf of St. Lawrence is also considered a major threat.

Some of these climate changes could generate business opportunities while others could generate significant risks for several sectors. For example, heat waves, aggravated by the urban heat island effect, will affect public health and could increase the cases of mortality and morbidity. Other effects, such as the lengthening of the pollen season and the intensification of atmospheric pollution caused, by for example, the presence of air and cardio-vascular problems. Likewise, the decrease in ice cover as well as the increase in precipitation could result in major impacts, including erosion of the coastline and flooding. Ecosystems, like the forested areas, will also be heavily disturbed by the arrival and expansion of harmful invasive species. Impacts from global changes are already noted on the life cycles and distribution of trees, plants, migratory birds, salmonids and the iconic migratory caribou. Water management will be a worldwide issue in a changing climate. Conflicts of use associated with issues of quality
and availability of water are likely to increase and could have negative impacts on aquatic ecosystems and fish, habitat. Production of potable water in municipalities and agriculture needs among others.

To reduce the vulnerabilities and diminish the costs and magnitude of the expected risks, it is critical to take all necessary measures to adapt. Adaptation measures not only need to help people adapt, but they must be cost-effective so that they facilitate sustainable development and more importantly not increase greenhouse gas emissions. To achieve great adaptation measures, all stakeholders within a given system need to be included in the process. This way the multidisciplinary and sometimes multicultural teams can identify issues and search for solutions together taking into account all vulnerabilities on a territory. It is therefore easier for them to implement these adaptation measures when they are directly involved in the identification process.

Québec possesses tools and expertise that could be put to use to reduce vulnerabilities, while leveraging possible opportunities arising from global warming. Revising laws and regulations, building and maintaining infrastructure according to improved design criteria and practices as well as early warning systems to reduce impacts on human health constitute tangible examples of adaptation options already implemented. The question now is not whether we may need to adapt but rather how we can optimize the way we adapt to climate change.

P-3311-09
Tracking leading indicators to understand decarbonization trends and impacts of climate policies
C. Cronin (1) ; S. Menon (1) ; S. Monteith (1)
(1) ClimateWorks Foundation, Advisory & Research, San Francisco, CA, United States of America

Over the last year, ClimateWorks Foundation with other collaborators created the Carbon Transparency Initiative (CTI) tool with the objective to provide a transparent, global, and comprehensive assessment of greenhouse gas (GHG) emissions across regions and sectors based upon current policies, decarbonization trends, and expected investments. The CTI tool is an open-source, indicator-led methodology based upon a fundamental analysis of a small number of underlying driver metrics that shape long-term emissions. It allows for comparing current regional emissions trajectories to other scenarios and targets as well. It can also be used to track developments across nations at the sector level, and to some extent the ambition level of climate policies in different regions. Overall, it serves as a tool to evaluate the acceleration, deceleration, and efficiency of climate change mitigation actions. This presentation will review the main findings of the CTI for five focus regions, and compare scenario projections and decarbonization trends with other major modeling and tracking tools and will evaluate the impact of specific climate policies on GHG emission reductions.

The CTI tool, as designed, provides transparency of emissions in China, the EU–28, India, Mexico, and the US, for which the methodology distinguishes between 11 sectors: power, transportation, oil and gas, buildings, steel, cement, chemicals, ‘other industries’, agriculture, forestry, and waste. The tool presents analysis on leading indicator statistics for each sector, and uses these metrics to both determine future emissions trajectories and benchmark current decarbonization trends. Appropriately, 10 additional countries are being added in 2015 in partnership with the Climate Action Tracker (CAT) group, though with less detail. All combined, the CTI will be able to evaluate decarbonization trends and impacts of climate policies in countries that account for 75% of global emissions.

Many of the highest-emitting countries are undergoing rapid changes. When extrapolating historic GHG numbers for these countries, forecasts and scenarios can fundamentally underestimate saturation and maturity effects, and neglect the impact of irreversible costly infrastructure that may limit current and expected climate policies. CTI’s methodology is uniquely designed to forecast emissions trends out to 2030, taking into account saturation points, macro and technology shifts in the economy, and climate policy implementation, and conducts fundamental analysis on a small number of key drivers of global emissions. The tool relies upon a number of trusted sources, including the International Council on Clean Transportation (ICCT), Bloomberg National Energy Finance (BNEF), International Energy Agency (IEA), and others. In addition, by providing a high level of granular visibility into its components and indicators, with all of its outputs broken by region, sector and covering the time period between 2010 to 2030, the CTI tool is designed for annual tracking of key driver metrics for the next few years that help understand and contextualize trends in decarbonization and implementation of climate policies.

P-3311-10
S. Garren (1)
(1) Hofstra University, Geology, Environment, and Sustainability, Hempstead, New York, United States of America

The purpose of the session is to assess the current state of climate policy and greenhouse gas (GHG) emission trends in the four most populous states in the United States (i.e., California, Texas, New York, and Florida). Together these states comprise one-third of the total United States population. Each state faces different challenges in meeting climate change mitigation and implementation of different approaches to climate policy. The session will be organized by the three research questions that guided the research: 1) What has been the policy response to the threat of climate change from each of the four states and its local governments?; 2) What were the GHG emission trends from 2000 to 2010 in the four states and its local governments?; and, 3) What were the drivers of change of greenhouse gas emissions? Research was conducted to systematically catalogue climate policy within each state and specific actions taken at the local government level. Actions taken at the local government level included participation in one or more of eight climate networks and completion of a GHG inventory and/or climate action plan. A comprehensive GHG inventory was completed for each state (2000 through 2010) and for selected local governments (2000 and 2010). GHG emissions were summarized for total GHG emissions, per capita GHG emissions, and by sector (i.e., energy, transportation, industrial processes, agriculture, waste, carbon sequestration, and for miscellaneous other categories). Data availability at the state level is robust; however, readily-available data for all local governments continues to be problematic. The research also provides recommendations on data collection improvements at the local government level, better tracking of the evolution of local government policies and to make comparisons among local governments. Policymakers need accurate data and a framework by which to measure progress towards reduction targets and mitigation strategies aimed at reducing GHG emissions.

P-3311-11
Localizing climate policy responses: Explaining local government responses to climate impacts in the United States
D. Kauneckis (1)
(1) Ohio University, Voinovich School for Leadership and Public Affairs, Athens, OH, United States of America

In the context of American public policy, local and state governments have taken the lead in innovating and implementing climate change policies. This has occurred both in terms of mitigation and adaption efforts. This presentation reports results from a study of the actions of local governments in response to climate change in the United States. The study required reporting of 1,277 public organizations at the city, county and sub-state levels engaged in climate change policymaking and implementation. The presentation focuses on climate adaptation efforts that the study identifies as this work as policy action taken that addresses a risk directly associated with climate impacts. The results examine the factors contributing to the likelihood that a local government organization has actively expended resources toward reducing climate vulnerability. It explores how
organizations collaborate and engage in collective action solutions that facilitate policy learning and innovative strategies to address climate risks. The variables examined include the type of policy action, exposure to real and perceived climate risks, levels of policy innovation associated with organizational collaborations, and the outcomes of these efforts. Additionally, it looks at the role of both informal and formal policy networks, sources of innovation, and the prevalence of horizontal and vertical collaboration. Findings contribute to the theoretical literature on institutional collective action, policy innovation and learning, and local public economies. The results present important lessons for local governments managing the challenges of climate change and a decentralized view of how climate policy can progress at the local level in spite of inaction at the national and international levels.

**P-3311-12**

**Multilevel Governance and Institutional Capacity for Climate Change Responses in Latin American Cities**

P. Romero Lankao (1)

(1) National Center for Atmospheric Research, Boulder, United States of America

Urban populations, economic activities and infrastructure are responsible for between 71 and 75% of global GHG emissions. However, often only a small fraction of emissions produced within a city is under the direct control of local governments. While cities are vulnerable to a suite of negative impacts that climate change is projected to aggravate, many adaptation options are also out of local reach. In these cases, other jurisdictions and actors, such as national governments or the private sector, may have control over regulations, investments and programs that drive and manage emissions and risk. Hence, in order to mitigate GHG emissions and adapt to the impacts of climate change a range of actors, across sectors and levels of government, will need to create multilevel and multisectoral coalitions for effective urban climate governance. Although mitigation and adaptation goals are, often of necessity, pursued in tandem by local governments, and urban climate policies are the product of multiscale influences, the relationship between multilevel governance and urban institutional capacity for mitigation and adaptation policies has only recently received attention, and studies focused on cities from Latin American countries are often missing altogether. We present work conducted through the ADAPTE project to explore some of the key factors or drivers shaping the institutional capacity to develop and implement mitigation and adaptation policies in the Latin American cities of Buenos Aires, Argentina, Mexico City, Mexico and Santiago, Chile. These cities have been molded by similar urbanization processes, neoliberal reforms, urban and environmental policies, and by the presence of scientific groups and multinational networks that have been instrumental in putting climate change on their policy agendas. We compare two late arrivals to the climate change policy arena (Buenos Aires and Santiago) with a frontrunner (Mexico City), and ask whether being a frontrunner is an indicator of greater institutional capacity to respond to climate change and whether barriers to creating institutional response capacity operate similarly across cities regardless of the status of their policy development.

**P-3311-13**

**Economics of Global Climate Policies of Adaptation and Mitigation: A Review**

MH8. Syed (1)

(1) Jahangirnagar University, Economics, Dhaka, Bangladesh

Climate change is uncertain all over the World. But its impact is visible everywhere. From the Arctic Ocean to the Tropics, climate is changing over the last several decades. Greenhouse gas is the major cause of the Global climate challenges before the Mankind. It has been found that fossil fuel CO2 is responsible for 78% of the total GHG gas emissions rise between 1970 and 2010. The concern about global warming was first raised in the UN Conference on Environment and Development (UNCED), which is also known as Earth Summit, held in Rio – De-Jenerio in 1992. Since then concerted work on climate challenges has been going on under United Nations initiatives. Conference of the Parties (COP) to the UN Framework Convention on Climate Change (UNFCCC) pledged that future Global warming should be restricted to below 2°C (3.6°F) in relation to the Pre-industrial level. This may be re-phased with a target of restricting global warming to below 1.5°C in relation to the pre-industrial level. Anthropogenic Greenhouse gases, a group of gases, are responsible for global warming. All the Members of the United Nations and the Members of Conference of the Parties(COP), Conference of the Parties(COP) is being held at different locations of the World since 1995. The 21st COP will be held in Paris in December, 2015. Now, the question is, how to adapt to the climate change and mitigate the severity of the climate change. This adaptation and mitigation policies will differ from one country to another. However, the combined effect of the global warming has to be contained by the end of 2100 A.D. According to some others, it should be contained by 2070 A.D. Some adaptation policies are characterized as a private good as the benefit goes directly to the individuals, regions or countries that implement them. Mitigation policies consist of switching to low-carbon energy sources for example renewable and low-carbon energy and to remove greater amounts of Carbon Dioxide from the atmosphere by enlarging forests and other sinks. It is estimated that the latter may increase energy efficiency. Climate Engineering is another method of mitigation. With limitations, Economics provides mechanism for examining the merits or demerits of taking or not taking action on climate change mitigation or adaptation in obtaining competing societal goals. The Stern Review on the ‘Economics of Climate Change’ is a report by the Economist Nicholas Stern of the London School of Economics and the University of Leeds. The Stern Review suggested that the costs of climate change could be contained within the range of -1 to +3.50% of World GDP (GDP(GWp)) with an average estimate of approximately 1%. The revised figure by Stern is 2% of GDP(GWp) To make a comparison in 2010, the World Product (GWP) at purchasing power parity (PPP) was estimated at $74.5 trillion. Therefore, 2% of the amount is $1.5 trillion. The Review includes prescriptions consisting of environmental taxes to minimize the economic and social disruptions. The Stern Review’s major concluding remark is that benefits of strong early action on climate change outweigh the costs of not acting. The Review points out the impacts of climate change on water, food, health and the environment. The Review says that without action the total costs of climate change will be equivalent to a loss of at least 5% GDP(GWp), each year now and forever.

**ABSTRACT BOOK**

**3312 - Planning and assessing adaptation: Frameworks, methods and results**

**K-3312-01**

Diversification: a safety net for Kenya’s dryland farmers in the face of climate change

M. Okoti (1); P. Ketiem, (2); J. Wamuongo, (2); A. Kipkoech, (3); M. Barare, (4)

(1) Kenya Agricultural and Livestock Research Organization, Environment and Climate Change Research, Nairobi, Kenya; (2) Kenya Agricultural and Livestock Research Institute, Nairobi, Kenya; (3) Eldoret University, Eldoret, Kenya; (4) Kenya Agricultural and Livestock Research Institute, Kisii, Kenya

**ORAL PRESENTATIONS**

**K-3312-01**

Diversification: a safety net for Kenya’s dryland farmers in the face of climate change

M. Okoti (1); P. Ketiem, (2); J. Wamuongo, (2); A. Kipkoech, (3); M. Barare, (4)

(1) Kenya Agricultural and Livestock Research Organization, Environment and Climate Change Research, Nairobi, Kenya; (2) Kenya Agricultural and Livestock Research Institute, Nairobi, Kenya; (3) Eldoret University, Eldoret, Kenya; (4) Kenya Agricultural and Livestock Research Institute, Kisii, Kenya

**3312 - Planning and assessing adaptation: Frameworks, methods and results**

**ORAL PRESENTATIONS**

**K-3312-01**

Diversification: a safety net for Kenya’s dryland farmers in the face of climate change

M. Okoti (1); P. Ketiem, (2); J. Wamuongo, (2); A. Kipkoech, (3); M. Barare, (4)

(1) Kenya Agricultural and Livestock Research Organization, Environment and Climate Change Research, Nairobi, Kenya; (2) Kenya Agricultural and Livestock Research Institute, Nairobi, Kenya; (3) Eldoret University, Eldoret, Kenya; (4) Kenya Agricultural and Livestock Research Institute, Kisii, Kenya
Climate change threatens livelihoods of the predominantly pastoral households in the arid and semi-arid land of Kenya, making about 50% of households in these areas food insecure. This will worsen given the pressures from climate change, unless there are changes in food production. In adapting to climate change, agro-pastoralism is being embraced. While this shift represents an innovation, the households are exposed to new risks and challenges in securing their livelihoods. This risks include increased drought, pests, diseases, temperatures and erratic rainfall. The main challenges include dwindling land sizes and limited agricultural know-how. The iDrC-funded Agricultural Productivity and Climate Change in Arid and Semi-Arid Kenya project set out to identify suitable crops for local conditions that would be readily acceptable to farmers, and to investigate water efficient farming systems that would be more productive under changing climatic conditions. Climate and rainfall information for the region was used to indicate current and future rainfall scenarios, forecast the onset of the planting season and identify suitable areas for different adaptation strategies. Working with 240 households, over three years, the project established demonstration field plots and farmer field schools to introduce appropriate climate adaptation strategies. These included drought tolerant crops, cover crops, use of organic and inorganic fertilizer and new production systems. Through the farmer field schools, farmers evaluated crops and assessed their acceptability. Prior to the project, households had reduced their arable land to 50% of the previous ten years by between 10% and 50%. Project interventions saw households who had planted alternative, drought-tolerant and high yielding crop varieties obtain up to 40% increases in yields. Households needed to allocate about 10% more of their arable land to food crop production, improving their household food security by 1%. Both local and crop production, households started to supplement their animal feeds with crop residues, increasing their feed supplies by 8%. There was a decline in the size of their livestock herds as they adopted cropping practices, but increases in crop production compensated for the reduction in livestock-based earnings. Planting in zai pits reduced crop yield losses during extreme dry weather by up to 40%. Use of organic fertilizer increased crop yields by up to 20% during severe drought and up to 30% during mild drought. By cultivating crops in former livestock pens, production was up by more than unfertilized fields, showing the importance of organic fertilizer, as a way to reduce the impacts of climate variability and change. Cost and benefit projections showed that crop diversification would yield over 40% increase in investment within the first ten years, with the potential of further significant increases in subsequent years. All targeted households influenced 3–5 other households, significantly increasing the adoption of adaptation strategies and to scale them up. Households with the highest diversity of crops traded in the market more frequently than those with fewer crops. The linkages and support from the County government ensured the great success of the project. The county government committed to invest about 10% more of their arable land to food production, improving their household food security and in ‘hot spot’ regions. The presentation will stress the importance of utilizing a consistent and operational conceptualization of adaptation, focusing on comparable units of analysis, using and developing comprehensive datasets on adaptation action, and being coherent with our understanding of what constitutes ‘real’ adaptation; collectively what we term the ‘4Cs of adaptation tracking.’

Assessing the climate change adaptive capacity at the city level, a case study: the Concepción Metropolitan Area, Chile

D. Araya (1) ; M. Metzger, (1) ; S. Neil (1) ; W. Meriwether (1) ; A. Luis (2) ;(1) Universidad de Edinburgo, Geosciences, Edinburgh, United Kingdom; (2) Pontificia Universidad Católica de Valparaíso, Geografía, Valparaíso, Chile

Despite the growing number of studies focusing on urban vulnerability to climate change, adaptive capacity, which is a key component of the IPCC definition of vulnerability, is rarely assessed quantitatively. This research examines the capacity of generic adaptation in the Concepción Metropolitan Area (CMA), Chile. A new approach is proposed to assess the urban adaptive capacity which is based on a set of indicators and fuzzy modelling techniques through Geographic Information System (GIS). A definition of this general procedure is proposed which provides consistency while allowing the required flexibility for application to cities under conditions of varying urban context, such as: jurisdiction, urban areas, and indicators. The factors understood that facilitate or constrain the process of adaptation were identified to revealed the differences between the level of adaptive capacity over time among the municipalities of the CMA. This allowed monitoring of changes in the spatial distribution of the adaptive capacity over time. This is the first extensive quantitative analysis of urban adaptive capacity in Chile.

The model of the city’s generic adaptive capacity was developed through fuzzy logic operations of ArcGIS software. This is based on seventeen indicators, derived from the adaptation index, which is mapped for nine municipalities within the CMA. The set of urban indicators were selected based on understanding. Rather than build on existing knowledge, initiatives, publications and theories have developed in a mushroom-like fashion. This creates a rift in the three domains of adaptation—science–policy–practice. In this context, this paper asks how measuring adaptation—i.e., adaptation networks and processes—can be applied when the conceptual underpinnings are debated and questioned.

Picking mushrooms: how to gather adaptation science, theory and practice in order to assess progress

L. Schipper (1)
(1) Overseas Development Institute, Stockholm Environment Institute, Berkeley, United States of America

By the 1990s, adaptation scientists had developed a rather sophisticated ‘typology’ of adaptation (see Smit, 1993; Smit et al., 2000), which reflected adaptation’s elusive character. They classified adaptation with various typologies that included different temporal and spatial scales and dimensions of consciousness. One of the most useful typologies to emerge from the early literature is the ‘4Cs’ typology of adaptation. This distinction has in many ways been the core notion that has given policy makers and practitioners an entry into adaptation. Yet subsequent scholarship on adaptation has been unable to develop a robust theoretical basis necessary to further a common understanding. Rather than build on existing knowledge, initiatives, publications and theories have developed in a mushroom-like fashion. This creates a rift in the three domains of adaptation—science–policy–practice. In this context, this paper asks how measuring adaptation—i.e., adaptation networks and processes—can be applied when the conceptual underpinnings are debated and questioned.

Adaptation tracking at global to regional scales

J. Ford (1) ; L. Berrang-Ford (1) ; R. Biesbroek (2)
(1) McGill University, Geography, Montreal, Canada; (2) Wageningen University, Public administration and policy group, Wageningen, Netherlands

Adaptation tracking seeks to characterize, monitor, and compare general trends in climate change adaptation over time and across nations. Recognized as essential for evaluating adaptation progress, there have been few attempts to develop systematic approaches for tracking adaptation, particularly at global to regional scales. This is reflected in polarized opinions, contradictory findings, and lack of understanding on the state of adaptation globally. This presentation will outline key methodological components of adaptation tracking research, and the challenges of producing systematic, rigorous, comparable, and usable insights that can capture the current state of adaptation globally, provide the basis for characterizing and evaluating adaptations taking place, facilitate examination of what conditions explain differences in adaptation action across jurisdictions, and can underpin the monitoring of adaptation over time. We will use examples from our work to illustrate approaches to adaptation tracking, including studies examining adaptation globally, in the EU, in the health sector, in urban areas with >1m people, and in ‘hot spot’ regions. The presentation will stress the importance of utilizing a consistent and operational conceptualization of adaptation, focusing on comparable units of analysis, using and developing comprehensive datasets on adaptation action, and being coherent with our understanding of what constitutes ‘real’ adaptation; collectively what we term the ‘4Cs of adaptation tracking.’

O-3312-01

O-3312-02
on the literature and created using data available at the municipality scale. As the same indicators were recorded for 1992 and 2002, they can be compared to reveal changes in the indicators over a 10 year period. This allows to understand the past conditions and factors contributing most to the positive or negative impact on maize productivity over the period, as well as those factors that have changed least.

Over the studied decade it can be seen that all the municipalities increased their level of adaptive capacity. However, the relative levels of adaptive capacity between the analyzed municipalities did not change significantly, this implied that the large differences observed between the municipalities in 1992 could be explained by the period studied. The results also show that municipalities with lower level of adaptive capacity in 1992 presented the highest increases in level of adaptive capacity by 2002. In contrast, those municipalities with highest level of adaptive capacity in 1992 showed less improvement. One interpretation that can be drawn is that economic factors such as the increasing income inequality found particularly in the rural areas is having a significant impact on the potential for further increasing adaptive capacity in these municipalities. These results suggest that efforts to improve the level adaptive capacity of the municipalities should focus not only on increasing the general adaptive capacity level, but also in reducing the wide disparities observed between municipalities.

The resulting indices enable monitoring of changes in the spatial distribution of the adaptive capacity and changes over time across the city. The resulting maps help identify areas where adaptive capacity is lacking or less developed. This can stimulate dialogue amongst policymakers and stakeholders regarding how to manage urban areas/ how to prioritise resources for urban development in ways that can improve the spatial distribution of adaptive capacity. Moreover, discussions on this paper can contribute to the climate policy in both city planning and national planning scale, e.g. the Chilean National Adaptation Plan (NAP). It highlights the benefits of a long-term vision sets towards reducing the field of vulnerability to climate change since allowed the straightforward standardization and consistent aggregation of indicators. The methodology developed for CMA can be readily applied for other cities in Chile and around the world.

O-3312-03
Impact of adaptation strategies on maize productivity under climate change: Empirical evidence from the Senegal River valley

A. Beye (1)
(1) Institut Sénégalais de Recherches Agricoles (ISRA), Bureau d’Analyse macroéconomique (BAME), Dakar, Senegal

Climate change challenges require, at the microeconomic level, the adoption of effective strategies to ensure production performance for achieving food security. Adaptation strategies for increasing agricultural productivity in the Senegal River Valley are of major importance for maintaining food security in the region. The objective of this study, therefore, is to investigate how adaptation strategies influence maize yield. The Senegal River Valley is one of the major food crops in Senegal. This traditional crop has been part of Senegalese consumers’ diet for centuries. However, maize cultivation is mainly raining. Approximately 40% of the maize-yield are obtained in the rainy season, which is affected by drought stress, with yield losses of 10 to 25% (Boone and al., 2008). To cope with irregular and insufficient rainfall, the yield of Senegalese farmers has adopted a range of strategies (NAPA, 2011). This paper’s main concern is to identify different types of adaptation implemented and quantify the impact of those adaptation strategies on maize productivity.

Materials and methods: This study was conducted in the Senegal River Valley which is one of the six agro-ecological zones of the country and where 8% of total arable lands are concentrated. The data used in this study was collected through surveys during the rainy season of 2013. The dataset encompasses 140 farms in the middle and upper Senegal River Valley. First, a frequency analysis is used to determine the adoption rate of coping strategies. Performing a student test, we identified strategies with a significant impact on maize productivity. Econometric estimates were then conducted for those strategies. Second, we used the endogenous switching regression model (Aalen and Manyong, 2007, Di Falcao et al, 2010, Di Falcao and Veronesi, 2011; Akpalu, 2011) to identify the determinants of the decision to adopt a given strategy. The model is to allow for an estimation of the impact of adaptation strategies on maize productivity.

Results and adaptation policy implications: The results show that 78% of farms in the middle and upper Senegal River Valley use at least one coping strategy. These strategies include the change of seeding date (percentual increase in yield by 247 kg/ha), the use of drought resistant maize variety (53%), the use of trees and shrubs fertilizers (4%), the direct seeding (7%), the use of biomass (1%) and irrigation (2%). The Student test shows that the change of seeding date and the use of short cycle varieties have a positive and significant impact on maize yield. For these two strategies, the differences in yields observed between farmers who adopt a strategy and those who did not is not a hazard. Estimates of endogenous switching regression model highlight the main determinants of the decision to adapt. Farm households that use fertilizers with individual fields are found to be more likely to change the seeding date and use of short cycle varieties. Likewise, farmers who belong to a producer organization are more likely to adopt coping strategies. Therefore, dissemination of these coping strategies would be more efficient through producers organizations than through extension services that have no impact on the decision to adopt a strategy. Results show also that in the Senegal River Valley, the change of seeding date is the best adaptation strategy to improve the maize productivity in the context of climate change. Indeed, the impact analysis shows that the change of seeding date increases maize yield in Senegal by 50% by 2022, while the use of short cycle varieties only increases it by 247 kg/ha. In terms of adaptation policy we propose the establishment of Climatic Information System which goal would be to provide information about climate to farmers through a multi–stakeholder platform gathering both producer’s organization and meteorological and extension services to better cope with climate change in Senegal rural area.

3312-POSTER PRESENTATIONS

P-3312-01
Formal and Informal Networks for Learning in Adaptive Risk Management in London, UK

T. Abeling (1)
(1) United Nations University / King’s College London, London, UK

Since the 2003 European heatwave, risk management and early warning systems for extreme temperatures have been developed in many European cities. London, UK, a global front-line city for adaptation, introduced comprehensive risk planning arrangements in the context of the 2004 National Heatwave Plan. Its annual rounds of review and its application through local government arrangements was examined in the framework of this poster presentation. They provide a unique opportunity to study, in a local government context, pathways and constraints for learning as an aspect of urban resilience. Empirical evidence from some of the early farm and city strategies reflects a multi-pronged approach towards adaptation that reinforced the status quo. Informal networks and trust relationships between risk planners compensated for formal heatwave planning arrangements that were-perceived as dysfunctional. This support from informal institutions to formal strategies undermined opportunities for paradigm shifts in risk planning. It suggests that social
Climate Smart Practices for Resilience and Sustainable Productivity: Sudan’s NAPA Case Studies

IE. Ali Babiker (1); F. El-Hag, (2)
(1) Agricultural Research Corporation, Dry Lands Research Center, Khartoum, Khartoum, Sudan; (2) Agricultural Research Corporation, Dry lands research center, Khartoum, Sudan

This study aimed at documenting climate smart practices implemented by NAPA at four States (River Nile, Gedaref, North Kordfan and Darfur) in Sudan. This documentation was done through reviewing the progress attained regarding implementation of innovative activities with the objective of enhancing the resilience of the targeted communities. Climate smart practices identified include: Sand dunes fixation, forestry and rangelands rehabilitation, micro-fences in rangelands, improved rain water harvesting practices, groundwater harvesting for establishment of community managed horticulture gardens, energy substitutes, and livestock improvement activities. Areas rehabilitated on over 28,000 ha, with range plants and tree seeds and seedlings were over 600 ha, clay soils areas covered with agroforestry, windbreaks and rangeland rehabilitation were 105.0, 21.0 and 84 ha, respectively. Rainwater harvesting structures were constructed to improve trees and rangelands rehabilitation. Shelterbelt was established covering an area of 300 ha. Range plants seeds were also, broadcasted inside fenced areas. This was done through communities’ participation, particularly women. Rainwater harvesting technologies enables farmers to break out of the cycle of poverty through increased crop yield, enhancing their adaptive capacity through improved food security, livelihoods. Improved water harvesting practice resulted in an increased sorghum yield over 477%. Cucumber, tomato and okra yields and protected vegetables harvested water harvesting techniques accrued a profit of over $1000. The intervention of groundwater harvesting, which involved 199 women and using solar energy operated pumps, provided a viable practice for enhancing community adaptation to climate change through food security and income generation. Over $2500 were stated to be the revenue from different activities of the horticultural garden due to groundwater harvesting. Cylinders and stove units were distributed relieved pressure off the fragile natural resources through provision of alternatives to tree cutting for charcoal making and for firewood collection, improving the nutritive value of Adar grasses and crop residues helped improving livestock feed balance in these areas in view of the deteriorated rangelands, particularly during the dry season. The study revealed several success stories and learning lessons.
Paleoenvironmental research has shown that significant climatic changes happened during the mid- and late Holocene yet it is hard to generalize changes in crucial climatic events throughout the Near East. The Amuq Plain is located at the northern terminus of the Jordan Rift Valley. The region has been recognized as a hot spot for biodiversity in the modern era (ancient Antioch, the Ur of the ancients). The Amuq Plain has been settled and its resources have been used intensively in the last 10,000 years, which has become a hub for social interactions. Consequently, the Amuq Plain has a lot to offer in studying the dynamic and multifaceted history of human–environmental relationships, especially the adaptive responses to climatic changes in the Holocene. Although untangling such relationships in time is essential, given the complexity of the geology of the Plain (i.e., tectonic, fluvial, and colluvial processes), spatial dimension becomes equally important. Contextualizing the range of human adaptive behavior in the Plain, across space and time, requires analyzing diverse sets of data. In Amuq Plain archaeological, economic, social, historical, and political data, environmental data are also needed to have a more accurate and complete reconstruction of adaptive patterns.

My talk will focus on correlating the results of the Macrophysical Climate Model with the long-term archaeological settlement systems on the Plain, which have been documented through traditional survey methods as well as remote sensing, geoarchaeology, and paleoenvironmental research. Macrophysical Climate Model (MCM) is a new paleoclimate modeling tool that has been available to researchers. In comparison to other paleoclimate models, MCM has higher spatial resolution and the results are synoptic (i.e., local). Research in different parts of the Near East suggests that the results of MCM agree well with the results from multi-proxy based paleoenvironmental reconstructions. The model output provides quantifiable figures at centennial resolution. In my talk, first, I will present the output from MCM that provides average annual precipitation and temperature between 12,000 and 2,000 cal. BP (ca. 10,000 B.C. – 0). Calculating annual averages at centennial resolution, changes in precipitation and temperature will be plotted. Then, I will interpret the possible impacts of climate change on the settlement systems of the Amuq Plain at spatial and temporal scales. In this comparison, the size, function, preference of land formation, and distance to the nearest water source will be analyzed using geographical information systems (GIS).

P-3312-07
Climate Change Adaptation of Watershed Key Stakeholders in Talomo-Lipadas Watersheds, Davao City, Philippines
N. Branzuela (1)
(1) University of Mindanao, Department of Forestry and Environmental Studies, Davao City, Philippines

Talomo–Lipadas Watershed, Davao City, Philippines is the main groundwater source for drinking water of 99% of the urban population in Davao City, Philippines (Hearne, 2011). Yet, these watersheds are in surmountable threats because of continuous land conversion, unavoidable development, unregulated water extraction, among others. Threats are exacerbated because of potential impacts of Climate Change.

The study aims to determine Station–scale climate projections using Statistical Downscaling; groundwater recharge determination using Brook 90 hydrological model; projection of water demand using per capita method and lastly, identification of Climate Change Adaptation Strategies of three key stakeholders groups.

Results revealed that months of March and April are likely to experience intense temperature along with a low flow recharge to groundwater, and this pattern will likely sustain until the next two slice period of 2050 and 2080. Moreover, the projected water demand is increasing from 101.26%, 228.18%, and 355.10% for the slice period of 2020, 2050, and 2080, respectively. With the potential Climate Change impact to water sources, water deficit of ~31.22 and 91.52 MCM (million cubic meters) is projected for time slice period of 2050 and 2080, respectively.

P-3312-06
Assessing adaptation on the ground: a proposed framework to measure adaptive capacity
MA. Baudoin (1); G. Ziervogel (2)
(1) Climate and Development initiative, geology, cape Town, South Africa; (2) University of Cape Town, Cape Town, South Africa

Methods for evaluating adaptation projects are a growing concern, in both the applied and academic spheres of climate change adaptation (CCA). Internationally, there is increased funding for climate adaptation projects; yet limited exploration of how this international funding is landing on the ground and impacting on adaptation. The key objective of our research is to highlight evidence of how externally funded projects have been implemented on the ground and how international funding is contributing to building adaptive capacity and implementing CCA. The core research question that guides the study is: what is the role of international funding in building adaptive capacity across scales, and across different country contexts? This question will be addressed with a specific focus on how international funding enables or undermines adaptive capacities among local institutions (both governmental and non-governmental).

The initial phase of the study is based on a review of existing literature exploring roles of international development funding on building generic and specific adaptive capacity. The review will also serve to capture methods and approaches to measuring adaptive capacities on the ground. The literature review will inform a framework to track adaptive capacities at the local level, during the implementation of CCA programmes funded by international organisations. This first phase will be followed by the second phase that will evaluate the programme “Taking Adaptation to the Ground: A Small Grants Facility (SGF) for Enabling Local Level Responses to Climate Change”, funded by the Adaptation Fund and implemented in the Northern Cape in South Africa. The SGF programme’s main objective is to empower local organisations so that their capacities to access external funding for CCA and to implement contextually–relevant adaptation programme are significantly enhanced.

Due to the early stage of this research, the presentation will focus on the result of its initial phase. More specifically, we will present a framework to assess adaptive capacities on the ground, among local institutions. This framework is based on a review of existing literature and on an in-depth assessment of institutional configurations within the studied area (Northern Cape, South Africa). This type of research is critical to help provide an increased understanding of what constitutes an effective institutional configuration that supports the implementation of successful internationally-funded CCA strategies in developing regions. This work is important for informing future scaling up and replication of small grant–financing approaches.
Stakeholders have fragmented priorities in their adaptation strategies. Domestic water users’ planned adaptations are mainly for demand-side adaptation rather than supply-side adaptation. Watershed Managers’ planned adaptation is to tap surface water and tree planting. Policy makers aim to fully implement City Ordinances pertaining to Watersheds.

**P-3312-08**

**Socio-economic aspects in the spatial differentiation of vulnerability to climate change in river basins**

R. Corobov (1)
(1) EcoTiras International Association of River Keepers,
Chisinau, Moldova

The measurement of vulnerability to climate change is a central moment in adaptation activity to mitigate adverse climatic impacts. Both natural and social scientists try to measure and assess such vulnerability, whether from the perspective of regions, socio-ecological systems, or individuals. Different approaches to this issue have penetrated into climate change research, and with rapid growth of attention to vulnerability, the concept itself has been re-defined, and new interpretations and approaches were developed.

Climate change represents a classic global problem characterized by infinitely diverse actors and multiple stressors at multiple scales. As a result, research on vulnerability to this phenomenon have to address at least three important challenges: (1) to improve approaches for comparing and aggregating impacts across diverse sectors and populations, (2) to model socioeconomic transitions with an assessment of the significance of these impacts, and (3) to account for multiple dimensions. Different challenges result in their different ‘diagnoses’ and different kinds of ‘cures’.

Initially, the assessment of vulnerability to climate change was approached from the impacts point of view where it was defined as the degree to which a system is susceptible to, and unable to cope with, climatic change. However, recently the emphasis in these efforts has moved from better defining exposure and potential impacts to a better understanding of factors that affect sensitivity of societies to these impacts and their capacity to adapt. There is an increasing recognition of the importance to consider the social component of vulnerability equally with the biophysical one, thus presenting vulnerability as a function both of physical characteristics of climate change and of social systems’ inherent sensitivity and adaptive capacity. Various research studies try to bridge the gap between social, natural, and physical sciences’ contributions to multiple methodologies that confront this challenge, primarily under the umbrella of sustainability and resilience. On the other hand, a system of vulnerability ‘measurement’ still captures the ‘integrated complexity’ of interacting social and natural sectors and their susceptibility to climate change risks and capacities to deal with them. Climate change consequences first of all are experienced at regional and local levels, varying between communities, social groups in a community and even between individual households.

Based on evidences that surface waters are especially sensitive to changes in climate, the main goal of this contribution is to present the pioneer assessment of socio-economic vulnerability to climate change of the Dniester basin’s “hotspots” and different kinds of economic systems sensitivity to climate change. The contribution is to present the pioneer assessment of socio-economic vulnerability to climate change of the Dniester basin’s “hotspots” and different kinds of economic systems sensitivity to climate change.

**P-3312-09**

**Bottom-up initiatives for flood risk management in Europe: How can we evaluate governance processes and spatial outcomes? (TRANS-ADAPT research project, JPI-Climate)**

A. Gatin-Tournait (1); M. Fournier (2); G. Mathilde (1); M. Bonnefond (2); S. Servain-Courtant (3); D. Clarke (4); P. Driessen, (5); S. Fuchs (6); D. Hegger (5); H. Mees, (5); C. Murphy (4); T. Thaler (6)
(1) Université François-Rabelais Tours, UMR Citeres CNRS 7324, TOURS Cedex 3, France; (2) ESCT–CNAM, Le Mans, France; (3) INSA Centre Val de Loire – ENSNP, Blois, France; (4) National University Ireland Maynooth, Irish climate analysis and research unit (Icarus), Dublin, Ireland; (5) Copernicus Institute of Sustainable Development, Utrecht university, Utrecht, Netherlands; (6) University of Natural resources and Life Sciences, Vienna, Austria

The aim of the proposal is to present the Trans–Adapt research project and its assessment framework that will be applied to community-led bottom-up climate change adaptation strategies. Trans–Adapt (awarded by the European Joint Programming Initiative–Climate) focuses on bottom-up initiatives to flood risk management. In the context of climate change that triggers more extreme meteorological events, including severe floods, strategies are developed by local authorities, sometimes with the collaboration of civil society. These initiatives intend to make land allocations to flood risk management more efficient and socially beneficial. However, the Trans–Adapt project assumes that these initiatives are different from mainstream flood risk management measures, because of: (1) the novelty, (2) the necessity to consider the social component of vulnerability as a function both of physical characteristics of climate change and of social systems’ inherent sensitivity and adaptive capacity. Various research studies try to bridge the gap between social, natural, and physical sciences’ contributions to multiple methodologies that confront this challenge, primarily under the umbrella of sustainability and resilience. On the other hand, a system of vulnerability ‘measurement’ still captures the ‘integrated complexity’ of interacting social and natural sectors and their susceptibility to climate change risks and capacities to deal with them. Climate change consequences first of all are experienced at regional and local levels, varying between communities, social groups in a community and even between individual households.

The overall aim of the project is to analyse, explain and evaluate similarities and differences across four European regions in terms of climate change adaptation performance, with a particular focus at the local–individual household level, burden–sharing and equity issues. The purpose is to understand these challenges and limitations of current policy and institutional arrangements, such as benefits and costs of adaptation measures at different levels.

The proposal will present Trans–Adapt research questions and the conceptual framework for assessment and evaluation of our case studies, which will give insights to the parallel session ‘Assessing adaptation’ in Day 3. Preliminary results from one French case study will be used as illustration of the assessment framework application.

In order to identify the barriers and limitations of the current governance and management structures in flood risk management, the project develops an analytical and evaluation framework that focuses on efficiency, effectiveness, legitimacy, accountability, social justice and social capacity, as classical policy analysis criteria. Moreover, we carry on a reflection on feasibility and vulnerability of the risk management processes and outcomes, in a policy design concern.

The assessment framework will adapt the chosen criteria to the specific topic of flood risk management, providing operational indicators that will be used to evaluate the 12 case studies.

The final objectives of the project will be to explore the possibilities for up-scaling and replicating local initiatives in other countries and outlining the institutional change required to facilitate local initiatives, by providing a means of guiding the decision–making process at different levels of authority.
ABSTRACT BOOK

Prioritizing Climate Impact Risks at the Neighborhood-level: Applying a Hazard Vulnerability Analysis for Los Angeles County

B. Moy (1); H. Godwin, (1)
(1) UCLA Fielding School of Public Health, Environmental Health Sciences, Los Angeles, CA, United States of America

Los Angeles presents a unique challenge in assessing local climate impacts on human health due to the county’s diverse neighborhood demographics, numerous jurisdictions, and varying geography and microclimates. High-resolution climate models are needed to assess the risk to climate change impacts at the neighborhood-level. In order to address these impacts, it is necessary to develop a Regional Climate Adaptation Plan to prioritize activities and build resilience strategies to minimize the negative impacts of climate change.

Our analysis to assess the flood/drought disaster risk by Latin Square Design (LSD) using statistical software SPSS reveals direct relationship of degraded ecosystems and sustainable livelihoods. This is due to the processes of land use conversion to forest, farmland, and urban and rural land uses that are compounding the losses to the small and marginal farmers who are peasants with small land holding and agriculture labors primarily. Interestingly some measures adopted by the farmers and the state policies to resolve the ecological crisis are indicative of strategies to combat the threat. One of the means of weather based crop insurance is also felt important as untimely weather fluctuations are compounding the losses to the small and marginal farmers and many have succumbed over the last decade. This paper attempts to highlight impending issues in the context of Uttarakhand a Northern State of India focusing on issues of sustainability which is pivotal.
The effects of ecosystem-based adaptation on vulnerability to climate change: evidence from semi-arid Brazil

M. Obermaier (1) ; MC. Lemos, (2) ; YJ. Lo, (2) ; AM. Bedran, (3)

(1) Universidade Federal do Rio de Janeiro (UFRJ), Instituto Alberto Luiz Coimbra de Pós-Graduação e Pesquisa de Engenharia (COPPE), Rio de Janeiro, Brazil; (2) Pontificia Universidad Católica de Chile, Departamento de ingeniería hidráulica y ambiental, Santiago, Chile; (2) Pontificia Universidad Católica de Chile, Centro de cambio global ur, Santiago, Chile; (3) Centro de Cambio Global UC, Pontificia Universidad católica de chile, Santiago, Chile

Assessing the effectiveness of adaptation strategies in rural parts of developing countries is important, but relatively understudied topic. One important question is the effect of social interventions and anti-poverty programs on vulnerability and influence the possibility of social transformation. This research aims to contribute to this debate by providing empirical evidence of the role of anti-poverty programs in building vulnerable households’ adaptive capacity to climate impact.

While there is growing evidence that poverty is a robust predictor of vulnerability, there is also growing attention to the ways they do not overlap and/or the different ways they do overlap (Olson et al. 2014, Nelson et al. in review, Patt 2012). In this context, so-called ecosystem-based adaptation (EBA) strategies – i.e. options that combine community management of natural resources with specific and technical assistance and production methods – may be less evident in Latin America as means of reducing vulnerability to climate extremes while simultaneously contributing to local sustainable development (Magrini et al., 2014). While the role of sustainable use of biodiversity for climate adaptation is relatively unquestioned, there is little evidence on the effects of reducing social vulnerability, particularly when assessed in the context of ongoing anti-poverty programs.

This study assesses the effects of ecosystem-based sustainability projects on smallholder farmers. We focus on our research on drought-vulnerable communities in Northeast Brazil where we have already carried out research and collected longitudinal data at the household (i.e. 1998, 2002, 2012) and at the level of livelihoods, technological innovation, environmental sustainability and vulnerability to drought (Lemos et al., 2002; Obermaier, 2013; Obermaier et al., 2014; Simões et al., 2010; Tompkins et al., 2008). Climate projections for NE Brazil indicate a strong likelihood of decreased precipitation, resulting in more aridization and drought (Magrini et al., 2014), with a further exacerbation of social vulnerabilities to currently sensitive populations in the region.

Our motivation for carrying out the research in Brazil is the ability to locate the analysis in the context of a much larger social experiment in poverty elimination implemented by the Brazilian government since the late 1990s called Programa Bolsa Família. The program provides a conditional cash allowance to all households with school age children and whose income is below a minimum amount established by the government. In order to qualify for the allowance families have to enroll and keep their children in school and provide basic health care (e.g. vaccination). One hypothesis behind the Bolsa Família program is that it will slowly eliminate severe poverty in Brazil and even potentially transform the livelihoods of the segments of the population that currently live below the poverty line (below 2 dollars a day).

First evidence by our research supports the hypothesis that although Bolsa Família is necessary for families it is also insufficient to reduce vulnerability to drought. On the other hand, ecosystem-based strategies carried out by smallholder farmers and conservationists of Biodiversity Programs in NE Brazil seem to enable rural farmers to maintain their food security (including access and nutrition values) at higher levels as well as to contribute to income generation.

Empirical findings from this research will critically contribute to both scholarship and policymaking. Currently, there is disproportionate attention paid to individual and policy makers alike question the best types of actions to reduce the risk of experiencing harm derived from extreme events particularly within the developing world where losses are expected to be significantly higher. In order to support household adaptation, policy makers must decide whether it is more effective to invest in measures that will reduce vulnerability to a broad range of both climatic and non-climatic stressors, or whether it is best to focus on enhancing specific capacities to manage particular hazards. In terms of the livelihood framework, policy-makers must decide which types of livelihood assets should continue to be targeted for investment and support. This research will contribute to this debate by providing empirical evidence of the role of anti-poverty programs in building vulnerable households’ adaptive capacity to climate impact.

Water security indicators for a climate variability and climate change adaptation process in the Maipo River basin in Central Chile

A. Ocampo-Melgar, (1); J. Gironás, (2); S. Vicuna (3)

(1) Pontificia Universidad Católica de Chile, Departamento de ingeniería hidráulica y ambiental, Santiago, Chile; (2) Pontificia Universidad Católica de Chile, Centro de cambio global ur, Santiago, Chile; (3) Centro de Cambio Global UC, Pontificia Universidad católica de chile, Santiago, Chile

Observed climate change effects are challenging government and societies to start thinking how to adapt to an even more extreme range of potential future changes that will impact many aspects of our lives. As this need for adaptation arises so does the practical details about how to successfully implement adaptation measures. This research is also investigating the socio-ecological complexity of systems involved. The Maipo river basin is an example of such systems that most likely will need to adapt in the future due to climate change. The Maipo river provides water for over six million people and to more than 200.000 hectares of agricultural land and many other productive outputs (e.g. mining, hydropower) and non productive activities in the region. Previous studies have shown that future temperature and precipitation changes will result in future stress to the already water scarce basin, but could also result in future floods events due to a rising zero degree isotherm.

To face the multiple demands in an uncertain future with climate change, the challenge is to align adaptation strategic goals with social and private sectors as well as the civil society. This research will require information and tools to concentrate efforts in the most relevant aspects of life that will need to be adapted to. To respond to this need, a three-year project (2012-2015) entitled MAPA (Maipo Adaptation Plan for its initials in Spanish) is being implemented in collaboration with a multi-stakeholder platform of around 30 public, private and civil society organisations, including different political levels and regional bodies. The objective of the project is to both identify vulnerabilities and adaptation options to potential future scenarios. In the basin, the project works with the scientific team and the multi-stakeholder platform of around 30 public, private and civil society organisations to design adaptation scenarios and the basin and three working groups (i.e. mountain/natural systems, rural sector and urban sub-sector). This project is guided by the Robust Decision Making framework that incorporates both stakeholders expertise and computational capabilities in a mutual feedback process to identify future scenarios, appropriate tools and models, adaptation measures and Performance Indicators, which are a key outcome. These indicators allow identifying the most vulnerable vulnerability levels and the understanding of the benefits of implementing adaptation measures given uncertain scenarios.

Since water is the common link between the diversity of threats and demands at different scales in a basin, we used the Water Security definition by the U.N. to frame a participatory process that includes performance of water security, the development of Performance Indicators, and measure climate change impacts in a way that could trigger the implementation of adaptation measures. In order to operationalize the definition into the adaptation process, we disaggregated water security into its five main sub-components (i.e. economic development, livelihoods, ecosystems conservation, protection against hazards and protection against water-borne diseases). Each of these sub-components were intensively discussed with the working groups. A set of factors, demands and aspirations determining security in different settings was identified in the three temporal scales were identified by each working group (e.g. flow of water for rafting, volume of minerals extracted or turbidity in water). The indicators, relationships and casual links among them were analyzed and consolidated in order to generate a conceptual model to characterize water security.
in the Maipo basin.

The guided but still highly participatory process implemented in this study identified causal links and scales of indicators, which in turns will allow defining metrics and options for adaptation to be used as early signs in this adaptive plan in process. The water security conceptual model goes beyond capturing water physical manifestations, as it attempts to make visible hidden connections to ecosystem goods and services and human aspirations that represent human well-being, which could be finally impacted by climate change.

The approach has also the potential to capture the general aspirations of the different users in a basin related with economic development, ecosystem conservation, basic human needs, pollution and hazard allowing in this way not only to design of adaptation measures that have a physical water representation but also measures that are closely related to the final objectives that water security tries to achieve: human well-being.

P-3312-15
Emerging Response to climate change and Variability in Semi-Arid Areas of East Africa

E. Ogalo (1); E. Komutunga (2); G. Sabiti (3); SM. Mikalitsa (1)
(1) University of Nairobi, Geography and Environmental Studies, Nairobi, Kenya; (2) National Agricultural Research Organization, Kampala, Uganda; (3) Makerere university, Kampala, Uganda

Arid and semi-arid regions are characterized by insufficient rainfall to sustain agricultural production. The rains are erratic and often come in a few heavy storms of short duration resulting in high run-off, instead of replenishing the ground water. Protective vegetation cover is sparse and there is very little moisture for the most parts of the year. Communities in these regions are particularly vulnerable to climate change not only because of their dependence on climate sensitive sectors but also due to limited capacities to anticipate and effectively respond to climate change. The main objective of this study was to determine the emerging coping and adaptation strategies of the local communities in Semi-arid Regions of East Africa with a view of enhancing their resilience and reducing vulnerability to climate change and variability. The paper is based on the synthesis and comparative analysis of coping and adaptation strategies employed by different countries in East Africa. The study found out that the communities and local governments are investing on several adaptation activities to address impacts of climate change in semi-arid areas. These include rainwater harvesting, furrow irrigation, and livestock and agricultural production needs. The availability of this water resource significantly reduces community vulnerability to impacts of climate change. Water availability and water conservation structures provide opportunities for the local community to diversify their economic activities through the cultivation of high value horticultural crops under drip irrigation systems. The pastures and improved fodder grasses planted under furrow water conservation structures provide the opportunity for the local community to produce pastures/fodders during the dry periods. The provision of appropriate investment and conservation structures in ASALS is crucial toward enhancing resilience and adaptation of the local communities from the adverse vagaries of climate change. Other projects such as cropping and agronomic adaptation options that promote already existing best management practices should be implemented. There is also a need for the integration of local knowledge in government climate policies to improve adaptation and enhance local adaptation strategies.

P-3312-16
Climate Change Adaptation and Vulnerability Assessment: A case Study of Lesser Himalaya

BW. Pandey (1)
(1) University of Delhi, Department of Geography, Delhi, India

Climate change and land use degradation are accelerating water induced hazards such as cloudburst, flash floods, riverine floods, surface erosion and landslides in Himalyan geosystem. Himalayas, due to their complex geological structure, dynamic geomorphology, and seasonal hydro-meteorological conditions experience very frequent natural disasters, especially water induced hazards. Natural hazards have had significant impacts on life and property in areas with high population densities and land use intensity. The escalation of risks and vulnerability has come about through population growth and land use intensification in the areas, both of which have incurred upon hazard zones and in some case, such as road construction on slopes, have exacerbated the hazard of slope failure. The association of deforestation, rainfall and steep topography was augmentative.

Climate Vulnerability Index (CVI) is being proposed to assess climate change vulnerability of communities with a case study in high mountain areas in the Beas River valley of lesser Himalaya. The indices considered being all the parameters of all the three dimensions of vulnerability such as Exposure, Sensitivity and Adaptive Capability. Exposure is defined by Natural disaster and Climate variability, however Sensitivity by Health, Food, and Water and Adaptive Capability by Socio demographic profile, Livelihood strategies, and Social networks.

P-3312-17
Smallholder farmers in the Great Ruaha River sub-Basin of Tanzania: coping or adapting to climate stresses?

NM. Pauline (1)
(1) University of Dar es Salaam, Institute of Resources Assessment, Dar es Salaam, Tanzania, United Republic of

Climate change and variability are pervasive contemporary realities in Africa. In this paper, we investigate the changes that have occurred in the Great Ruaha River sub-Basin (GRRB), Tanzania. By making use of a mixed-methods approach, including both quantitative and qualitative data collection methods, we demonstrate that climate stresses have increased since the 1990s, as have limiting factors constraining effective and sustainable response options. By interrogating data from smallholder farmers for group discussions, household questionnaire surveys and records in government institutions we show that sustainable livelihoods in this area are compromised by non-climatic stresses such as a lack of coordinated crop markets and poor access to loans, weather forecast information, and to irrigation infrastructure. Smallholder farmer responses to climatic stresses (i.e. resources utilisation, farming methods diversification) have changed over time, which is consistent with the changes in coping strategies that are adopted in response to specific barriers. Barriers to adaptation include limited access to irrigation water, crop markets and loans. Consequently, smallholder farmers are resorting to shorter-term coping strategies more frequently than longer-term adaptation to impacts of climatic stresses, and are thus still heavily reliant on social, economic and policy support to improve their adaptive capacity.

P-3312-18
Generating Knowledge and Capacity for Climate Change Impacts and Adaptation for Water Security

F. Picado (1); O. Jordan (2); M. Moran (3); O. Smith, (3); J. Guardia, (3); CLA. Del (4); J. Perez, (2); M. Oyuela, (2); C. Santos, (5); J. Contreras, (6); H. Alvarado, (7)
(1) Water Center for the Humid Tropics of Latin America and the Caribbean (CATHALAC), Simon Bolivar General, Panama, Panama; (2) CATHALAC, Panama, Panama; (3) CATHALAC, Research, Panama, Panama; (4) CATHALAC, Ict, Panama, Panama; (5) Ios (Usac); (6) Tecnologico Institute of Santo Domingo (Inotec, in Spanish), Environmental dept., Santo Domingo, Dominican Republic; (7) CUNOC / USAC, Quetzaltenango, Guatemala

This research seeks to narrow the existing gap between scientific knowledge on climate change impacts on water resources and efforts made to implement on site solutions. We are working with water management institutions in Central America and the Caribbean. Hence, from the start, these institutions were involved, in two prioritized countries, to assess climate change impacts and adaptation measures on water resources in this region. Regional, national and municipal
scales of analysis were used in a pilot basin in each of the two study: the Dominican Republic and Guatemala. Research was done together with universities, ministries of environment and other stakeholders from two municipalities per basin, making it one of the key approaches to achieve the objective of incorporating decision makers, water resource managers and other stakeholders, aims to promote the application of the findings and the use of research results and to strengthen learning and management skills for beneficiaries and the organization leading the research.

For the climate change models for the region published in the IPCC Fourth and Fifth Assessment Reports (AR4, AR5), we performed a comparative analysis, in terms of future water availability. It is among the main results of the project, to date. Based on technical criteria, we chose four of the Concentration Pathways scenarios (RCPs). These models were inputs to scaling and dissemination of results.

Regional community as a means to promote sustainability, built together. It will provide results and products already advances in guiding adaptation policy through knowledge public resource-sharing platform will complement the sectors. It identified the different local strategies that responsibilities, policies, regulations and investments to found that conflicts and gaps existed in the institutional analysis of water resources management, conducted by countries. The studies were complemented by a thorough policy and investment studies were specific to both pilot projects-22 countries in this region and can be used in their next Haiti and Guatemala, Hydrologic and climate modeling with a soil and Water Assessment Tool (sWat) provided a more detailed analysis on the two basins. Results will be available in a public website, for consultation by the 21 countries in the region and can be used in the Next Climate Change National Communications. Project-sponsored universities, national researchers, and students collectively performed vulnerability analyses in the pilot basins. The National study was designed in countries with information available, to understand how the countries invest on climate and water resources. It showed that more than 60% of investment funding comes from external sources. From this 60%, three quarters go to the implementation of programs and costs of operation and maintenance of infrastructure. One quarter goes to actual infrastructure or hard investments.

In the policy framework, the Roman law system prevails for Central America and in the Caribbean, the so-called common law applies. Differences in motivation are evident in the regulatory frameworks among the Caribbean Community (CARICOM) member countries and the Central American Integration System (SICA) countries. Both policy and investment studies were specific to both pilot countries. The studies were complemented by a thorough analysis of real life cases of extreme events in order to assess the actual preparedness for climate change. We conclude that this method is useful for identifying the expected climate change preparedness level, and recommend to combine this with ex post analyses of real-life cases of extreme events in order to assess the actual preparedness for climate change. With this method, we intend to assist policy-makers in developing and implementing adaptation plans at various levels.

Keywords: adaptation; climate change; responsibilities; ex ante assessment method; the Netherlands.

P-3312-20

A comparative sustainability analysis of conservation agriculture in the Mediterranean: the AClimas project

A. Scardigno (1) ; V. Giannini (2) ; L. Bonzanigo (3) ; D. Chami (4) ; M. Morabito (5) ; MT. Abi Saab (6) ; Y. Shakhatreh (7) ; C. Gippioni (8)

(1) CIHEAM—Mediterranean Agronomic Institute of Bari (IAMB), Land and Water Resources Management, Valenzano, Italy; (2) Centro Euro-Mediterraneo sui Cambiamenti Climatici, Venezia, Italy; (3) Copernicus Institute of Sustainable Development, Utrecht University, Utrecht, Netherlands; (2) Utrecht Centre for Water, Oceans and Sustainability Law, Utrecht, Netherlands

Climate change related risks encompass an intensification of extreme weather events, such as flooding, droughts and heat stress. A transparent and comprehensive division of responsibilities is a necessary – but not the only – precondition for being prepared for climate change adaptation. This method proofs particularly suited for the assessment of adaptation responsibilities in combination with a sectoral approach. It helps identifying a number of shortcomings in divisions of responsibilities for climate adaptation. We conclude that this method is useful for identifying the expected climate change preparedness level, and recommend to combine this with ex post analyses of real-life cases of extreme events in order to assess the actual preparedness for climate change.

With this method, we intend to assist policy-makers in developing and implementing adaptation plans at various levels.

The sustainability analysis of selected combinations of genotypes and water management practices (including畦耕 system and conservation tillage) is here interpreted as an analytical approach towards the long-term perspectives. The selected combinations, specifically chosen as potential alternatives to current farming practices, should help farmers cope with more frequent droughts induced by climate change, as well as being able to sustain their farms’ activity over time.

We present here the sustainability assessment of different Mediterranean case studies of analysing trade-offs among environmental, economic, and social performances of farms from the Chaouia Region in Morocco, Bekaa Valley in Lebanon and in Irbid Governorate in Jordan growing mainly cereals and legumes improved varieties tolerant to water, heat and salinity stresses. Several combinations of different genotypes, fertilizers practices, tillage systems and water management practices will be the basis to develop Municipal Adaptation Plans. Research results plus lessons learned, will be used to prepare the guidelines to optimize public investment in climate change adaptation on water resources. Local stakeholders have already integrated into a «Participation Focus Group (GFP)» in each country basin in a process that promotes learning, communication and empowerment of results. They have participated in the whole process, strengthening their knowledge, perspectives; validated methodologies and monitored research outcomes, and provided recommendations. A public resource-sharing platform will complement the approaches and additions identified by this. The selected combinations will be built together. It will provide results and products already obtained, and the new ones we expect to obtain. This platform aims to engage and share with the rest of the researchers community as means to promote sustainability, scaling and dissemination of results.

P-3312-19

Prepared for climate change? A method for the ex ante assessment of the completeness, transparency, legitimacy, and expected effectiveness of responsibilities for climate adaptation

H. Runhaar (1) ; C. Uittenbroek, (1) ; RM. Van (2) ; H. Mees, (1) ; P. Driessen, (1) ; H. Gillissen, (2)

(1) Copernicus Institute of Sustainable Development, Utrecht University, Utrecht, Netherlands; (2) Utrecht Centre for Water, Oceans and Sustainability Law, Utrecht, Netherlands

The sustainability analysis of selected combinations of genotypes and water management practices (including畦耕 system and conservation tillage) is here interpreted as an analytical approach towards the long-term perspectives. The selected combinations, specifically chosen as potential alternatives to current farming practices, should help farmers cope with more frequent droughts induced by climate change, as well as being able to sustain their farms’ activity over time. With this method, we intend to assist policy-makers in developing and implementing adaptation plans at various levels.
Climate Change and Adaptation Capacities in Ethiopia: Constraints and Opportunities

RB. Singh (1)
(1) Ethiopian Civil Service University, Urban Environment and Climate Change Management, Addis Ababa, Addis Ababa, Ethiopia

Assessment carried out under Ethiopian National Adaptation Program of Action (NAPA) indicates that, agricultural, water and human health are the most vulnerable sectors to climate change in Ethiopia. The present paper focuses on the agriculture sector, as agriculture production complemented with pastoralist production, provide livelihood to about 80% of the country’s population. The activities are very sensitive to the changes in the climate conditions. Further, available data indicate that, in Ethiopia climate change impacts may be severe and the existing adaptation capacities are not sufficient to deal with these severe problems. Therefore, this study was designed to assess the impacts of climate change and constraints and opportunities pertaining to adaptation capacities in Ethiopia. Due to the financial limitations, the assessment was limited to two woredas (districts) of the country-Gudura, Gudura region (predominately pastoral) and Mieso, Somali region (predominately pastoral). To achieve the objectives of the study both primary and secondary data was collected. Primary data was collected through a questionnaire survey of 100 farmers in Gudura woreda by simple random method and experts were chosen to assess the impacts of climate change and constraints and opportunities pertaining to adaptation capacities in Ethiopia. Due to the financial limitations, the assessment was limited to two woreadas (districts) of the country-Gudura, Gudura region (predominately pastoral) and Mieso, Somali region (predominately pastoral). To achieve the objectives of the study both primary and secondary data was collected. Primary data was collected through a questionnaire survey of 100 farmers in Gudura woreda by simple random method and experts were chosen to assess the impacts of climate change and constraints and opportunities pertaining to adaptation capacities in Ethiopia.
climate variability on rural livelihood. The respondents from the study area were interviewed using a standardized interview schedule or depending on their literacy level and availability, they were supplied with a questionnaire. Focus Group Discussions were set up to explore important issues regarding livelihoods in the community.

In data analysis basic statistics of mean, standard deviation, skewness, kurtosis and trend were used to show the central tendency of climate. The optimal fingerprinting (Paeth and Mannig 2012) was applied in order to quantify climate change signals in the light of internal climate variability.

Africa’s development efforts in the continent over depend on natural resources which are vulnerable to climate change and variability. This study used multinomial logit models to analyze the effect of spatial and temporal climate variability and change on household adaptation. The Heckman model was used to assess whether households perceive climate variability and assess their decision making process to adapt or not. The data was collected from a survey of about 400 households using semi-structured questionnaires. The climatic data were obtained from Kenya Meteorological Headquarters at Dagoreti as well as from grided observational and regional climate model data sets. This study used the newest CMIP5 and CORDEX model data sets for the assessment of climate variability and change over eastern Africa. The study was designed to have an in-depth understanding of climate variability and change at small area within on regional scale. The results of this study have been helpful in influencing the policy markers’ decision making process in the face of climate variability adaptation measures at both national levels.

Households in both rural and urban settings experienced huge burden to adapt to persistent climate variations. The variations were hardly predictable within space and time and frequently they induce disasters such as prolonged droughts or floods which have heavy burden to human livelihoods. The study established that traditionally, people used the indigenous knowledge to predict certain climate changes; they also managed to cope with changing climates through applying certain adaptation measures such as planting different crop varieties, improving water conservation techniques and keeping livestock as a buffer to crop failure. Today the paradox is that people are not aware of changes in climate and the indigenous knowledge which was significant is now scanty in the face of scientific knowledge.

P-3312-24

Key climate change adaptation deficits in Indonesia: Sectoral coordination and local capacity building

R. Joseph-Paulus (1); R. Hindmarsh, (2)
(1) Local Government of Buton Selatan Regency, Regional development planning agency (bappeda) and dayanu ikhsanuddin university (unidayan), Baubau, Indonesia; (2) Griffith University, Environmental politics, policy and stgs griffith school of environment, and centre for governance, Brisbane, Australia

The commitment to mainstream responses to climate change adaptation and capacity building agenda is acknowledged in several government regulations. Many obstacles hinder such efforts, especially the lack of clarity over the functions of central and local governments and lack of capacity within the governments to administer new functions due to decentralization. To encourage Indonesia’s participation in this global issue, there is an urgent need to identify ways to develop national capacity, including local government due to their significant roles to mainstream climate change adaptation into development agenda. This paper outlines the findings of a field trip to central and several local governments in Indonesia to seek the views of policy-makers, researchers, community representatives and other key actors related to climate change adaptation. Emphasised areas for enhanced adaptation policy development were: first, institutional strengthening through the enhancement of sectoral coordination and capacity building to ensure the adequate institutional setting and capacity. Second, non-effective sectoral coordination among government agencies there needs to be elevated synchronisation of crosscutting issues, and the development of appropriate coordinating agencies and appropriate guidelines for the local level of climate mainstreaming (adaptation) into development. In turn, for enhancement of capacity building there needs to be elevated local governmental and civic awareness raising, promotion of government and non-governmental partnerships; and greater availability of scientific assessment and incentives as well as inclusion of local social and traditional knowledge.

P-3312-25

Assessment of Socioeconomic Vulnerability to Floods at Small Area Level in Malawi

S. Zhang (1); M. Bangalore (2); D. Schensul (1); S. Hallegatte (2)
(1) United Nations Population Fund, Technical Division, New York, United States of America; (2) World Bank, Climate change group, Washington, DC, United States of America

Vulnerability assessments involve indicators and measurement methodologies to assess the vulnerability of socio-ecological systems, for example to natural disasters such as floods. Flood events directly and indirectly threaten people’s health, livelihoods, food security, and deepen poverty. Flood is expected to worsen with climate change, and has disproportionate impacts on different segments of the population, for example children, youths, adolescents, people with disability, and immigrants are more generally more vulnerable to the impacts of floods. In many urban areas, inequities will become more apparent with higher concentration of vulnerable people in less desired but higher-risk locations. There is urgent need for incorporating socioeconomic vulnerability and equity factors into climate change adaptation planning and development policies. In this paper, we examine the vulnerability to flooding in Malawi at small area levels, integrating a number of datasets.

In Malawi, we will integrate socio-demographic data with hazard data and examine vulnerability at the small–area level. We employ census data for demographic, housing quality, and service data, World Bank estimates for poverty data, and Demographic and Health Survey (DHS) data for education and nutrition data. This socio-demographic data will be merged with spatial hazard data on flood risk in Malawi, from two global hydrological models (GLOFRIS and CORINE). As socio-demographic data is at the 2nd administrative boundary level, and hazard data is at high-resolution, the vulnerability analysis will be done at small area level, based on the level at which decision-making processes are made. The joint paper will identify a suite of indicators to develop a vulnerability index, and examine where high vulnerability coincides with high risk from flood, through spatial and statistical analysis.

The project will pilot the vulnerability index and assessment in Malawi, a country with increased pressures from population dynamics, poverty and natural disasters, where the climate data and information are sorely lacking. In addition to examining socioeconomic vulnerability, the index can be disaggregated to provide information on each dimension (demography, health, economic and flood). By disaggregating vulnerability at small geographic level over four dimensions, the project aims to better understand the socio-demographic vulnerability to floods, in a context of climate change. It is also in line with the post-2015 Sustainable Development Goals and targets by contributing to strengthening resilience and adaptive capacity to climate-related hazards and adaption, as well as providing evidenced data by small geographic location. The data, index and methodology applied in this project may also be scaled-up to more countries.
Coordinated adaptation to future climate change, Concept and case studies in China

K. Jia (1); C. Fu (2); Z. Ma (1)
(1) Chinese Academy of Sciences, Institute of Atmospheric Physics, Beijing, China; (2) CAS Institute of Atmospheric Physics and Nanjing University, Beijing | Nanjing, China

Human societies have continuously adjusted themselves to meet the dynamics of climate since ancient time, long before global climate change is considered as a threat to issue. Traditional approaches for climate change adaptation are often based on certain sector or administrative unit, and lack of coordination or integration across those boundaries. Such barriers among sectors and administrative units often cause conflict interests and compromised overall effects of those efforts. In some extreme cases, the adaptation strategies developed by one sector could even lead negative impacts on other sectors or areas. Therefore, different sectors and subregions are encouraged to work together to develop coordinated and integrated adaptation strategies at regional and global scales, in order to achieve optimal effects for sustainable development. Here we propose and discuss the possible pathways, i.e., coordinated adaptation strategies, towards integrated approaches for climate change adaptation across sectorial and administrative boundaries. Such pathways ask policy and planning at the scale of an entire region or subregion and cutting across sectorial boundaries. The proactive and coordinated adaptation planning potentially affects all sectors and all parts of a region. Cross-sectoral and cross subregion policy coordination mechanisms will also be discussed with several case studies related to regional urban clusters and dryland watershed management in China in response to climate change.


PC. Tiwari (1)
(1) Kumaun University, Geography, Nainital, Uttarakhand, India

Hindu Kush Himalaya constitutes headwaters of some of the largest trans-boundary basins of planet. The ecosystem services, particularly the freshwater flowing down from the Himalayan headwaters sustain one-fourth global population dependent primarily on subsistence agriculture in Pakistan, India, Nepal, and Bangladesh. Climate change has stressed hydrological regimes of Himalayan headwaters through higher mean annual temperatures, fast melting of glaciers and snow, altered precipitation patterns and increased incidences and intensity of extreme weather events causing substantial decrease in water availability and increasing frequency and severity of hydrological hazards. This may increase pressure on water, food, health and livelihood insecurity population in entire South Asia which represents one of the most water stressed, food insecure and energy deficit regions, and inhabited by some of the poorest people of the world with access to less than 5% of planet’s freshwater resources. This will have enormous regional implications for fundamental human endeavors ranging from poverty alleviation to environmental sustainability and climate change adaptation, and even to human security and peace in the region. A coordinated regional adaptation framework
is therefore highly imperative not only for responding to local impacts of climate change and achieving water, food, and energy security, but also for attaining post 2015 Sustainable Development Goals (SDGs) to provide social and economic sustainability to more than 40% global population living in the region.

The main objective of the study is to evolve a coordinated regional trans-boundary headwater management framework for minimizing the role of the critical sub-region of Hindu Kush Himalayan (HKH) ecosystem services in sustaining food, water, and energy security in South Asia under climate change. In order to attain this the study: (i) analyzed the mutual environmental and economic benefits of integrated trans-boundary headwater management; (ii) investigated reasons and rationale for missing regional cooperation among riparian countries; (iii) explored geo-political constraints in initiating effective regional cooperation dialogue; (iv) evolved an institutional framework for effective trans-boundary headwater governance in Hindu Kush Himalaya through the analysis of secondary data collected from varied sources. Besides, comprehensive study of available literature and media reports, interpretation of people responses obtained through interviews, interaction with political leadership and policy planners across Hindu Kush Himalayan countries formed the basis of this study.

Study revealed that despite geographical and cultural complexity of Asia, the geo-jenics of Asia proposed as it is one of the most disintegrated regions of the world characterized by political tensions, armed conflict, and extreme political instability and economic imbalances. It was observed that political transition, threats of internal and external security, weak leadership, and long standing conflictual inter-state dynamics are important reasons for missing regional cooperation in trans-boundary water management for freezing hydro-diplomacy in the region. Further, the results clearly indicated that the issues and challenges in the food, water, and energy sectors are interlinked in several complex ways and cannot be managed effectively without cross-sectoral integration and regional cooperation. The study also identified a range of important potential benefits of regional cooperation in integrated water resources which include: (a) sharing information for developing integrated flood forecasting and early warning system for different basins, (b) storing water in upstream river basins for flood moderation, (c) storing water resources for increasing flow in dry seasons, (d) accumulating water for inland water transport, (e) harnessing water resources to generate hydroelectricity, and (f) managing watersheds to help increase the quality and quantity of water available, irrigation, industries, drinking and sanitation by downstream users. A number of regional and local institutions, particularly International Centre for Integrated Mountain Development (ICIMOD) and South Asia Association for Regional Cooperation (SAARC) are determined to play an active role in initiating regional water cooperation in South Asia.

O-3313-02

Coordinated Regional Adaptation to Sea Level Rise — A Case Study of Land Use and Transportation System

S. Shen (1)

(1) University of Hawaii at Manoa, Urban and Regional Planning Department, Honolulu, France

In recent years, many research efforts have been made to study the impact of climate change, especially sea level rise, on transportation system at the local level. While these studies provided many useful insights for the vulnerability of transportation system to sea level rise, few analyzed the impacts of adaptation strategies (i.e. protection, accommodation, planned retreat) on the local transportation system. Furthermore, the diversity of study contexts, the variety of methods utilized, and the lack of standard evaluation metrics make it difficult to compare the findings of different studies. This gap between adaptation strategies, corresponding long term land use change, and transportation system performance are not thoroughly studied. To bridge this research gap, three adaptation strategies with different disruption levels and land use schemes are analyzed using Tampa, Florida as a case study. Transportation system vulnerabilities to sea level rise under three scenarios are characterized using multiple performance measures. Vehicle hours travelled (VHT) shows to be the most sensitive performance measure to transportation vulnerability change. Without any adaptation strategies, the regional transportation system could have 40% VHT increase under 2ft sea level rise. Protecting up to 108 miles of freeway/bridges could prevent about 18% of VHT increase, while large scale traffic analysis zone internal capacity protection or development retreat have less than 2% contributions. Supposing the average value of travel time savings in Florida is $32 per hour, protecting up to 108 miles of freeway or bridges would generate a saving of more than $30 million per day. If the cost to elevate road is $2 million/mile, it takes about a week for the benefit to recover the cost. Consequently, even with neighborhood flood prevention and planned retreat strategies, protecting coastal freeways and important bridges would be necessary and cost-effective to adapt to sea level rise for the case study area. The results of the case study illustrate that communities outside the inundation zones or lowlying areas are also vulnerable to sea level rise and their activities are supported by critical infrastructures (i.e. transportation in this case study) within the inundation zones. Without long-term coordinated regional land use and transportation planning, adaptation strategies focus only on accommodating or relocating local vulnerable communities might not be effective at the regional level.

O-3313-03

Making adaptation policy integration work in local government: Lessons from Australia

H. Fuenfgeld (1); A. Macarthur (2)

(1) RMIT University, School of Global, Urban and Social Studies, Melbourne, Victoria, Australia; (2) RMIT University, School of global, urban and social studies / Centre for urban research, Melbourne, Victoria, Australia

Considering and planning for the impacts of climate change has entered the mainstream of local government policy level, yet much experimenting is still taking place about how adaptation can meaningfully and effectively be tied in with existing policy agendas and integrated into policy making, across departmental boundaries and organisational hierarchies. Over the past decade, there has been slow recognition that, from an organisational perspective, climate change adaptation needs to be broadly anchored in an organisation; for adaptation to be effective and comprehensive, it cannot simply be another task of environment departments or sustainability officers.

While many adaptation policy frameworks point to the need for such systematic and deep integration and recommend high-level actions, not many empirical studies exist that document the strategies that complex organisations pursue to embed adaptation, nor is there much empirical evidence as to whether these strategies are effective. While key barriers to integration are known, many organisations still struggle to make much progress with embedding adaptation across divisions, departments or operational units.

This paper presents, for the first time, empirical findings from two research projects concerned with embedding adaptation in the local government sector in Australia. The focus of the analysis is on intra-organisational processes for embedding adaptation across an organisation, although some inter-organisational analysis is also highlighted. The local governments that participated in these research projects are highly exposed to multiple climatic stressors and their impacts, including sea-level rise, bushfire, flooding and heatwaves. They provide interesting case studies for adaptation policy development and implementation at the local government scale, adding to our understanding of the role of institutions in climate change adaptation.

3313-P-POSTER PRESENTATIONS

P-3313-01

Regional climate change adaptation and mitigation in the North German Plain — a cross-sectoral analysis of land use experts' perception

T. Barkmann (1); R. Siebert (1); A. Lange (1)
Adaptation to climate change in Tampere Region, Finland

T. Frisk (1)

(1) Centre for Economic Development, Transport and the Environment for Pirkanmaa, Environmental Information, Tampere, Finland

Adaptation to climate change will be one of the most important issues in the different regions of Europe. Adaptation plans cannot be made only internationally or nationally but local and regional authorities must have the main be responsibility for adaptation planning. One of the four main themes of the Climate and Energy Strategy of Tampere Region is adaptation to climate change. The purpose of this presentation is to deal with the aims and the proposed actions of adaptation in Tampere Region.

In the strategy, the main general aim of adaptation is that people and different organizations of the region are reserved to governance of climate change phenomena. The aim is that impacts of climate change have been studied, their importance has been assessed and the most important actions of adaptation have been carried out in a cost-effective way, taking into account the aims of mitigation of climate change. Another aim is that awareness of the impacts of climations are round the hand of adaptation has increased. It is important that people realize that the change is permanent and the threats and also the possibilities of the changes are taken into account. For achieving the general aims, six main actions have been acknowledged:

- Research is utilized and comprehensive assessment of the impacts of climate change is made, as well as risk analyses and considerations of vulnerability.
- Skills of ordinary people in adaptation and reservation to the impacts of climate change are improved.
- Proactive and cost-effective actions of adaptation are carried out in practice.
- Adaptation to climate change is taken into account in the Biodiversity Programme of Tampere Region.
- The Centre for Economic Development, Transport and the Environment for Pirkanmaa (CETEP) is coordinating the cooperation in adaptation to climate change.
- In adaptation, the cooperation over the borders of the regions is considered.

More detailed aims have been presented for increased precipitation and humidity, increased temperature and extreme events. One of the main aims is that the risks of increased precipitation, humidity and temperature have been assessed and the most necessary actions have been carried out. Attention must be paid to the following issues for example: the amount of storm water and the capacity of sewerage systems, the condition of roads and streets, the increase of net energy production from agricultural areas, regulation of lakes and rivers, and the impacts of increased humidity on houses and other constructions.

The main aims connected with increased temperature are that new animal and plant species (including cultivated plants and trees) can be utilized, harmful alien species are recognized and the spread of them is restricted, and cooling of houses is carried out taking into account requirements of energy efficiency. Attention will also be paid the impacts of increased temperature on human health.

When extreme events are concerned, one of the main aims is that adaptation planning in the different sectors (local communities, industry, service, households) is sufficient. The other two main aims are that forecasts and informing about extreme events has improved and that the basic functions of society have been secured during more drastic and more often occurring extreme conditions.

For monitoring the proposed actions of the Climate and Energy Strategy of Pirkanmaa, a working group has been founded. The group is coordinated by CETEP and particular attention is paid to adaptation to climate change. The first report will be published in 2016.
P-3313-03

Flooding in the Urban Space: the Contribution and impact of law in relation to resilient Flood Risk Governance in the EU

S. Homewood (1)
(1) Middlesex University, Law and Flood Hazard Research Centre, London, United Kingdom

This presentation will take an overview of one of the most important environmental issues affecting more than half of the world’s population. How should environmental risk governance respond to climate change which is likely to have caused increasing problems of flooding in recent years and the increasing threat of flooding in the cities and urban spaces of the future? An important aspect of such governance arrangements is the impact and importance of a number of legal issues.

This paper will examine some of the law’s response to the problems of the governance of flooding. It will also make some comparisons with other EU Countries. This will include reference to the preliminary findings from the large 6 Million Euro EC funded STARFLOOD Research project on Flood Risk Management, with which the author and other colleagues are involved, together with 5 other European Universities.

P-3313-04

Promoting the consideration of the effects of climate change on Agriculture in Morocco

A. Lauuina (1)
(1) Faculty of Human sciences, Geography, Rabat, Morocco

The effort of adaptation to climate change must be involved in the fields of resource management and governance, by the research on the possible correlations between Climate changes and Management of resources: efficiency of institutions responsible for these resources, in order to better respond to the questions posed and propose ways of adaptation capable to mitigate the negative effects of the current trends.

On the political level, because of the strong interactions of the three domains, climate water and environment, it is advantageous to opt for integrated actions, winning on several plans: reduce the vulnerability, conservation of resources, development of agriculture and guaranty of water volume and quality.

Therefore propose measures with tangible effects, reform the decision-making process and place it on top of sector structures.

We can’t overemphasize the importance of anticipation, i.e. possess an elaborate knowledge, the result of advanced research, based on sufficient measures and studies. Careful planning is to be prepared, on the basis of a prospective based on reliable indicators. Finally, we must adopt policy choices and courageous management, by challenging myths that seemed established and proved, but recent studies seem to contradict.

Non integrated solutions with only a technical content can affect the consistency and efficiency of decisions and policies. It is necessary to collect sufficient data to validly base on the decisions and thus strengthen the links between scientific research and decision making. A sufficiently broad debate should take place, to compare the values, perceptions and views, to allow the decisions ownership by everybody. We must provide relevant and reliable scientific data and the results must be communicated to the general public and organizations, to ensure a sufficient level of awareness and commitment.

Adaptation is not exclusive to the most vulnerable farmers and most fragile lands. The rainfed land of the Atlantic plains of Morocco, considered as favorable, covered by large farms, in which aggregation of means permits to promote efficient agriculture, and which are directed by conscious farmers, in principle, of the possible impacts of climate change on the process of degradation, can suffer serious threats, especially because of the unexpected occurrence of the most recent dry period, either, are immune to environmental crises, especially in case of water stress. So we must be prepared for any eventuality and therefore adopt a clear and consistent path in the management policy in the event of occurrence of major risks.

An effective integration of climate change on agriculture, as in other sectors, implies the need for a clear commitment at the highest level of the state apparatus and ensures the contribution of the private and civil society to establish the conditions for the establishment and implementation of a structured and effective strategy.

P-3313-05

Climate change and necessary actions for Sahelian rural world. What choice and what measures for responsible authorities?

A. Ndiaye (1) ; MB. Timera (1) ; SD. Badiane (1)
(1) Cheikh Anta Diop University, Geography, Dakar, Senegal

In the Sahel, rural populations are increasingly faced with a decline in agricultural production due to various inappropriate methods of production but also and especially to the influence of climate change is manifested in the form of recurring hazards: droughts, floods, dry spells, the greater wind speed, etc. However, to ensure food security, more than 80% of rural depend on a hypothetical rainy winter, very disturbed in the course of its cycle. It follows strong pressure exerted on natural resources (Swakumar, 1993; Servat et al 1997, etc.).

These climatic disturbances that last for almost half century affected the bio-productive system and induces degradation. It appeared everywhere, the most degraded landscapes are those affected by overgrazing, agricultural pressure, where poor farming practices; the disappearance of fallow and lack of fertilizer supply has exacerbated a local phenomenon (Preliminary Report of the FAO project «Land Degradation Assessment,» FAO–CSE, April 2003, etc).

Thus, disturbances occurred on climatic factors, will have notable effects on the lifestyles of the population and socio-economic activities. They are facing, at the same time, to constantly risk situations and high vulnerability due to the lack of resources available to them to face the multiple pressures.

A diagnosis based on a field visit in 2014, with a project from F.A.O. (collection of basic information: individual interviews and focus group interviews with facilitators and leaders of structures, etc.) in Senegal, Gambia, Burkina Faso and Mali, has identified and assessed the adaptive capacity of farmers to climate change in relation to their livelihoods, to identify their roles and responsibilities but also those of the various technical and administrative services that support them in their fight against the effects of the phenomenon.

It appeared at the end of our research that, the main policy advice is that both addressing food and nutrition security and building resilience in agriculture and rural communities require an integrated approach of investing in long term production enhancement interventions, but also short term price and climate risk management strategies. Investing in responsive and sustainable safety nets that will enhance food and nutrition security can thus reduce the impact of short term risk factors. Once risk and vulnerability are not factored, hazards may reverse progress made over some years in most fragile and vulnerable countries and communities.

It appeared too, that the active participation of all stakeholders, enabling the development of the strengths and potential of rural areas and thus the assertion of economic identity, social, historical and cultural populations could assure them the well-being so aspired. Furthermore, the challenges of climate change in the context of globalization, there were proven everywhere (Smart Village, Eco Villages, etc.) that local development, will, in the future, more than in the past, a role key to play in ensuring a confirmed transformation of territories?

Ultimately, it will be discussed in the context of this paper, to correctly analyze climate trends indispensable for socio-economic projections, to study the factors (internal and external) that exacerbate the vulnerability of farmers and finally to assess the relevance of options / more effective coping strategies in the promotion of socio-economic consciousness and collective responsibility to build a regional project through an agreed methodology.
Rethinking Coastal Design and Planning: Integrated SLR Vulnerability Assessments, Case of Mombasa and Lamu Islands

V. Ochanda (1)
(1) Wits University, Architecture and Planning, Johannesburg, South Africa

The world coastlines are increasing in population due to their natural beauty, tourist attraction of the luxurious coastal cities leading to ever larger populations, and a vast interest in developing infrastructure at coastal areas. Sea level rise (SLR) is threatening the sustainability of coastal residents as well as the related infrastructure. The Low Elevation Coastal Zone (LECZ) defined here as the contiguous area along the coast that is less than 10 metres above sea level covers 2 per cent of the world land area but contains 10 per cent of the world's population and 13 per cent of the world's urban population. The least developed countries have 4 per cent of the world's population living in the LECZ compared with 10 per cent for the developed countries with the disparities widening in coastal urban areas at 21% and 11% respectively. Literature suggests that coastal cities in the developing world are ill prepared for the impacts arising from sea level changes and related storm surges. The Southern and Eastern African coastline (comprising the coasts of South Africa, Mozambique, Tanzania and Kenya), will regularly be affected by changes in cyclonic and other significant weather events that pose risks related to the development and infrastructure in these countries. The East African coastal islands of Mombasa and Lamu being relatively low elevated will become increasingly vulnerable to the associated risks of increasing SLR. Urban infrastructure development, use planning and design is most likely going to be impacted by the sea level rise on the coast. Being in the environment, these factors along the coastline will require a rethinking of coastal design and planning especially with regards to Sea level rise (SLR). The main purpose of the integrated actions on participatory vulnerability assessment was to identify adaptation strategies that are feasible and practical in both the local government and communities. The distinctive features of perception and adaptation analyses are shown. The participatory methods outlined and core elements of this approach are described. The specific objectives was to assess initial SLR vulnerability levels for the coastal strip of Kenya in terms of the zones, assets, infrastructure, public services, people and activities. Use GIS-based tools and techniques to determine and map out the extent of inundation risk for Kenya's coastal strip based on localized modelling from global inundation scenarios and a baseline assessment. Assess baseline sea level vulnerability awareness and perceptions through focus group discussions in order to understand the prevailing mitigation/adaptation practices and coping strategies in place, co-creatively evolve intervention or mitigation policy options for subsequent action and implementation. In this case meaningful and practical adaptations initiatives tend are enhanced when, climate is considered together with other environmental and social stresses. The important input was mainly the participation of the affected communities through the mini charrette on the concept of sea level rise, climate change and coastal adaptation and mitigation, especially in the context of the developing countries. The participation of the communities gave a great insight in the enhancement of the adaptation and mitigation strategies, and the absorption of climate change related mitigation and policy strategies for the two islands.

Adapting to climate change through local planning: The Bolivian Andes

PL. Pacheco Mollinedo (1); AL. Gonzales Carrasco (2); C. Carafa (1)
(1) Agua Sustentable, Climate Change Adaptation, la Paz, Bolivia; (2) Agua Sustentable, Climate change, la Paz, Bolivia

The manifestations of climate change contribute to increasing vulnerability to national development strategies. Every year more intense extreme weather impact on natural and human systems; impacting on the social and economic development in the Bolivian Altiplano. Studies by the National Climate Change Program in Bolivia (1997) and SENAMH (1998), predict future climate scenarios in the Central Altiplano of Bolivia, where variations in the cycle of rainfall and temperature increases with consequences of aridity.

Faced with this problem, there is an urgent need to build a solid foundation of scientific information, develop skills and knowledge management under which it will explore and identify the best options and tools for effective response to the impacts of change and climate variability using appropriate instruments and the use of technological and mathematical modeling, mapping rights, spatial tools, etc. To achieve this solid base of information, provide information to decision makers on the most effective use of the most appropriate destination of public investment funds and strengthen the governance structure to adapt to climate change.

An adaptation plan should address policy guidelines and adaptation to climate change in order to reduce the vulnerability of communities. In general, the policies relate to the objectives and the means of implementation, while the measures focus on actions to specific topics.

The construction of such a plan is based on social learning processes, methods and developed, adapted and tested for Sustainable Water tools, where both men and women in the communities participating in activities from the accompanying research, information gathering and building community action adaptation action plan and regional adaptation and analysis of lessons learned and planning.

Through the processes described, a methodological approach based on a sequential flow and simultaneous integrated actions in three fundamental axes parallel builds, which feed off each other (1) research, 2) Spaces of public, public deliberation, consensus and advocacy and 3) Planning and investments for adaptation.

The applied, collaborative and participatory work of local actors is the key in vulnerability analysis locally and expanding to a regional analysis as well as in identifying adaptation options to climate change, some of which are re-evaluated as traditional or ancestral forms of water management and some as new initiatives that are found from the research.

On the other hand, the second axis is social spaces of public deliberation. It is under this axis where the dissemination of knowledge for capacity building and strengthening works by promoting a roundtable of the basin where the actors are the same, both civilian and public. Finally, the focus of investment planning for adaptation is at the base of solutions to address climate variability and change tools built from the negotiating Regional Plan for Adaptation to Climate Change.

To meet future challenges involving climate variability and change, it is necessary a permanent improvement of the planning system (plans, programs, projects) to which this proposal contributes to the development of their own capabilities of the governors on the issue of adaptation. The principles of good governance imply that adaptation schemes are aimed at consensus, joint planning, effective, efficient, accountable, transparent, flexible, equitable, inclusive and law-abiding. These are basic principles to be considered to achieve reliable processes and establish legitimate institutions that lead to effective adaptation measures.

- Adaptation planning does not need to be separated from the already known planning development actions at local levels.
- Adaptation capacities of the municipalities can be improved by better allocating the funds for adaptation actions argued by the big losses after no adaptation

Municipalities can plan adaptation actions and level up those to the Programs for development at the Regional and National level.

Dynamic coherence of risk management and adaptation strategies in cities

R. Schwarze (1)
(1) Helmholtz–Center for Environmental Research, Economics, Leipzig, Germany
Decision-making in cities has a specific temporal character. It ranges from mainstreaming existing urban infrastructures and planning and more immediate measures to increasing the adaptive capacity of cities, to long-term transformations of urban living and design. Scaling urban challenges of CCA in time strongly relates to the analysis of risk management and adaption needs, measures and actions. Much knowledge is already available on the impacts of climate change and natural hazards on different sectors in cities and on associated existing vulnerabilities and risks, and many sector-specific CCA and DRM options are available. However, the existing methods and tools have not been studied for dynamic coherence. This paper aims to fill the gaps of risk management and adaption need in short term direct and indirect cross-sectoral impacts, vulnerabilities and risks of climate change, mid term levels of preparedness of cities (adaptive capacity) for these impacts, and robust long-term urban sustainability transformations for challenges going beyond existing adaptive capacities. It also covers the role of the private sector in short and long-term urban resilience programmes, with a special focus on municipal climate and resilience finance.

3314 - Innovate for addressing climate change challenges: examples from different industries

ORAL PRESENTATIONS

K-3314-01

Pioneers into Practice: initiatives for entrepreneurs

A. Thomas (1)
(1) Confederation of European Paper Industries, Brussels, Belgium

Abstract not communicated

O-3314-01

Producing pulp and paper in 2050: from incremental improvements to breakthrough technologies

B. De Galembert (1)
(1) Confederation of European Paper Industries, Brussels, Belgium

When the European Commission announced in 2011 its ambition to reduce the EU carbon emissions by 80% by 2050, the Confederation of European Paper Industries (CEPI), decided on its way to achieve that ambition. After the publication of its own roadmap, specifying the ways and conditions for the paper sector to reduce its own emissions by 80% and complementing it with an ambition to increase the creation of value in the sector by 50%, CEPI launched an open-innovation process to identify concrete technologies to reduce the carbon impact of the industry. The process was called “the Two Team Project”.

In November 2012, 2 teams composed of paper company representatives, experts from suppliers to the paper industry, scientists and researchers, free thinkers started to compete in identifying disruptive technologies to make pulp and paper differently and with much less energy and carbon emissions. Since the project was a competition, a pre-jury, followed by a jury had to choose a winning concept out to the eight that have been submitted by the teams. They assessed the concepts on the basis of 5 objective criteria, primarily on the contribution to the carbon emissions’ reduction, but also on the contribution to value creation, the feasibility of the idea, the conditions for success, as well as the overall innovativeness of the idea.

In November 2013, a winning concept was unveiled by Connie Hedegaard, at the time European Commissioner for climate action. Since then, consortia to further develop the concepts and carry out the needed research have been established.

Among the 8 concepts for breakthrough technologies in pulp and paper making identified by the teams, 5 are listed below.

1° Deep Eutectic Solvent for pulp making - the winning concept – is an adaptation of a natural phenomenon known from plant metabolism. Glucose-based DES can dissolve wood and extract in a selective manner cellulose, lignin and hemicellulose, hence allowing their use to produce different products. The dissolving process takes place at low temperature and atmospheric pressure. By using DES, the European industry can secure a low-carbon (~20%) and low-energy (~40%) production of pulp and use the other components in bio-based products or sell them to other industries.

2° Making paper with less water and no longer using the current energy-intensive drying techniques is feasible. The concept builds on the blowing of dry fibre into highly turbulent steam and the sheet formation by flash condensation combined with steam expansion, hence requiring a thousandth of the usual water consumption. The industry can reduce its energy needs by 20% and its CO2 emissions by 50%.

3° The current paper drying technique via heated cylinders leads to evaporating water by using air as a heat carrier. Increasing temperature and humidity towards “pure vapour” allows using this “superheated steam” instead of air as heat carrier. With this, large amounts of heat can be recovered and recycled. Using superheated steam for drying would deliver 25% energy reduction and up to 50% CO2 emissions reduction.

4° The use of a very highly consistent fibre input in the headbox requires the fibre to be placed into a very viscous environment to avoid flocculation, while protecting it from shear. The sheet formation is then achieved by pressing the dry pulp component which takes away 80% of the viscous component, and is followed by a curing technique to obtain a dry sheet. Energy demand is here reduced by 25% and CO2 emissions by 55%.

5° “Supercritical” is a stage where CO2 is neither a liquid nor a gas reached by combining a certain pressure and a certain temperature. Supercritical CO2 would allow drying paper in an autoclave with much less energy and therefore CO2 emissions. It provides the additional benefit of extracting contaminants in the recycling process. Ideally, the mill CO2 emissions could be the needed resource to run the autoclaves (carbon capture and use). The energy demand is expected to decrease by 25% and the CO2 emission by 45%.

The CEPI Two Team process has shown to be successful in showing that an open-innovation process can deliver realistic and disruptive concepts, provided the enabling conditions have been put in place.

O-3314-02

(Con)Fusing Durability Performance of Reinforced Concrete Structures with Environmental Sustainability

O. Alao (1)
(1) University of Cape Town, Department of Civil Engineering, New Engineering Building, Cape Town, South Africa

INTRODUCTION

Concrete is one of the most extensively consumed human-made material. The annual global consumption of concrete in 2013 was estimated at 25 billion tons per year, which implies a 90% increase in concrete consumption in comparison with that of 1950. The reasons for concrete’s significant use may be attributed to its numerous benefits which include its versatility, affordability and its ability to be engineered to suit desired performance. The consumption of concrete continues to increase with increasing world population and rate of urbanization. The world population is estimated to be about 7 billion, which is a 40% increase from the 1990 population statistic and it is projected to rise to 9 billion by the year 2050. Furthermore, with future projections of urbanization to reach 67% in 2050 from 36
3315 - Energy Innovation for Climate Change: systems approaches and societal responses

ORAL PRESENTATIONS

K-3315-01

The need for energy innovation: chair’s introduction

J. Skea (1); M. Hannon (1)
(1) Imperial College London, Centre for Environmental Policy, London, United Kingdom

Current energy technologies available to the market at scale are not capable of reducing CO2 emissions to levels compatible with achieving the UNFCCC goal of limiting global warming to 2°C. The last decade has seen a significant scaling up of both public and private sector energy RD&D efforts, but these have yet to reach the levels required to achieve climate policy goals. Indeed, much of the private sector effort will have the effect of extending the potential fossil fuel resource base leading to potential policy dilemmas.

Against this background, the objectives of the chair’s introduction are to: identify the needs for investment in energy RD&D; identify patterns of investment in R&D in both the public and private sectors; identify investment priorities and methods for establishing them; and consider what institutional frameworks and policy instruments will be most conducive to innovation that will help the achievement of a low-carbon transition. Energy innovation systems now transcend national boundaries due to international co-operation, the mobility of human capital and the activities of multinational companies. These factors will be sketched to help frame the session Energy Innovation for Climate Change: systems approaches and societal responses.

K-3315-02

A Systemic Approach to Assess Energy Technology Innovation

A. Grubler (1)
(1) IIASA, Transitions to New Technologies, Laxenburg, Austria

A systemic framework to assess energy technology innovation efforts, the Energy Technology Innovation Systems (ETIS), is outlined. ETIS describes innovation activities within both a systems perspective of all phases of a technology’s life cycle (R&D to maturity/
Stakeholder engagement in innovation and deployment

C. Mclachlan (1); S. Mander (1)
(1) University of Manchester, Tyndall Centre for Climate Change Research, Manchester, United Kingdom

Low carbon energy systems will require significant infrastructural transformation involving both novel technologies and new configurations of existing technologies. However, stakeholder opposition is a formidable barrier. To surmount this, we draw on a range of research that concludes stakeholders, and in particular how to reconcile expressed desire for the future energy system resilience support or challenge?

We use case study material to explore a range of themes at the deployment stage of energy technologies and set the scene for other panel contributions which focus more on the role (and potential role) of stakeholders in determining the overarching shape of the energy system. We draw together insights from a range of disciplines addressing common themes in low carbon energy controversies such as: different interpretations of impacts and benefits; governance, consultation and engagement activities; the role of governments and businesses. In particular we discuss on-going and current impacts on smart grids and future energy system resilience. Exploring, for example, the impact on deployment of tensions between the visions of ‘ideal’ consumers used by designers and engineers to support new technologies and the more messy reality of everyday energy consumption. A case study of siting a CO2 pipeline is used to examine how to engage local stakeholders, and in particular how to reconcile expressed desire for continuation and institutional mobilization insufficiently globalized to provide for an effective innovation system that can generate and diffuse required innovations in improved resource efficiency and low-carbon technologies. Selected quantitative examples underpin the assessment presented that emerged out of work conducted within the framework of the Global Energy Assessment (GEA).

Fuel du Jour: Cutting through alternative fuel hype to decarbonize transportation

O-3315-01

N. Melton (1); J. Axsen (2); D. Sperling (3)
(1) Navius Research Inc., Vancouver, Canada; (2) Simon Fraser University, Resource and environmental management, Vancouver, Canada; (3) University of California, Davis, Institute of transportation studies, Davis, United States of America

Achieving global climate mitigation objectives requires a significant shift to sustainable energy. Policymakers then communicate technological promises in order to attract attention and resources. Hype can play an important role in supporting successful innovation activities, but excessive hype increases the chance of failure. Unfulfilled promises and expectations undermine the reputation of new technologies and their developers, hampering resource mobilization and may lead to the abandonment of innovation activities.

Our research identifies and describes numerous cycles of AFV hype and disappointment, starting with methanol and natural gas in the late 1980s, moving through plug-in electric vehicles in the mid 1990s to hybrid–electric, hydrogen and biofuels in the early 2000s. Presently, expectations about plug-in electric vehicles are particularly high (although not for the first time). We show how automotive manufacturers and governments then communicate technological promises in order to attract attention and resources. Hype can play an important role in supporting successful innovation activities. While some degree of hype is desirable for stimulating interest and investment in new technologies, extreme and typically unrealistic promises related to AFVs are contrary to an efficient transition to low–carbon transportation. For policymakers seeking to induce such a transition, it therefore seems prudent to take steps to mitigate the negative impacts of hype and implement...
effective policy that is relatively immune to disappointment cycles. To accelerate the adoption of low carbon technologies, we suggest that policymakers: 1) set realistic goals for AFV market penetration, 2) implement strong and consistent policies to achieve desired penetration (i.e., technology agnostic policy focused on environmental damages), and 3) establish institutional capacity to inform expectations via technology assessment. These recommendations are likely applicable to other sectors where deploying low carbon technologies is important for achieving climate mitigation objectives.

O-3315-02

What role for climate negotiations on technology transfer?

M. Glachant (1) ; A. Dechezleprêtre (2)

(1) MINES ParisTech, Paris, France; (2) Grantham Research Institute – London School of Economics, London, United Kingdom

Technology has been an important topic of international climate change negotiations since the adoption of the United Framework Convention on Climate Change in 1992, in which the parties committed themselves to promote and cooperate in the development, application and diffusion, including transfer, of technologies. While technology transfer has been given a particularly high importance since technologies have so far been mostly developed in industrialized countries, but are urgently required throughout the world, including emerging economies where the bulk of future emission increases are expected.

Little progress has been made, however, in the climate negotiations on these issues. The only significant result to date is the establishment of a Technology Mechanism in 2010 in Cancun. It consists in two coordination bodies – the Technology Executive Committee (TEC) and the Climate Technology Center and Network (CTC&N) – the role of which is to elaborate and implement practical solutions to boost technology transfer and technology diffusion towards developing countries.

In this paper, we argue that this apparent lack of success has had little negative consequences on international technology diffusion until now. We even offer the perhaps controversial view that climate negotiations should continue to neglect technology issues.

We provide evidence that, despite the absence of progress on these issues, North – South technology transfer of climate change mitigation technologies has dramatically increased over the last twenty years, that concerns emerging economies which are now reasonably well connected to international technology flows. This is good news as these are the countries where most of emission increases are expected to occur in the near future. In contrast, least developed countries appear to have remained excluded from international technology flows. This evidence is based on an up-to-date analysis of the climate-related technology transfer landscape, based on a combination of patent data, bilateral trade data and foreign investment data. To the authors’ knowledge, this is the first time that such a comprehensive database on climate-related technology transfer has been assembled. Existing studies essentially rely on patent data (e.g., Dechezleprêtre et al. 2011). This evolution has mainly been driven by the growing integration of emerging economies to the global economy, as technological knowledge mostly crosses borders through the international trade of capital goods and Foreign Direct Investments. Similarly, the fact that least-developed countries remain outside is explained by their little participation in the recent economic globalization.

What, then, should be the priority for international coordination on technology diffusion in the future? In the case of emerging economies, there is no reason to think that they will not continue to effectively absorb foreign technologies. In this group, certain laggards – south Asia and India in particular – will benefit from a growing participation in economic globalization. This suggests a limited role for the Technology Mechanism which should essentially provide local private and public actors with information to facilitate coordination (e.g. through technology needs assessment) and to assist them when moving towards the international regulation of market mechanisms – in particular, trade rules and Intellectual Property – from the World Trade Organization to the UNFCCC.

O-3315-03

Engaging stakeholders towards low carbon energy technology deployment

P. Ashworth (1)

(1) University of Queensland, School of Social Sciences, Brisbane, Australia

No. 3315 Innovation, Technology Deployment and Policies FOR TYNNDALL CENTRE SESSION

Like many technologies, deployment of low carbon energy technologies in the transport sector, for example, requires a well connected community. This is a community that is far more inclusive. At the same time there has been an increase in the research literature – theoretical frameworks and models – that relate to this topic as governments and industry internationally are being held to account for their actions by their constituents and impacted communities. For example, there is a call for “negotiations on these issues. The only significant result to date is the establishment of a Technology Mechanism in 2010 in Cancun. It consists in two coordination bodies – the Technology Executive Committee (TEC) and the Climate Technology Center and Network (CTC&N) – the role of which is to elaborate and implement practical solutions to boost technology transfer and technology diffusion towards developing countries.

In this paper, we argue that this apparent lack of success has had little negative consequences on international technology diffusion until now. We even offer the perhaps controversial view that climate negotiations should continue to neglect technology issues.

We provide evidence that, despite the absence of progress on these issues, North – South technology transfer of climate change mitigation technologies has dramatically increased over the last twenty years, that concerns emerging economies which are now reasonably well connected to international technology flows. This is good news as these are the countries where most of emission increases are expected to occur in the near future. In contrast, least developed countries appear to have remained excluded from international technology flows. This evidence is based on an up-to-date analysis of the climate-related technology transfer landscape, based on a combination of patent data, bilateral trade data and foreign investment data. To the authors’ knowledge, this is the first time that such a comprehensive database on climate-related technology transfer has been assembled. Existing studies essentially rely on patent data (e.g., Dechezleprêtre et al. 2011). This evolution has mainly been driven by the growing integration of emerging economies to the global economy, as technological knowledge mostly crosses borders through the international trade of capital goods and Foreign Direct Investments. Similarly, the fact that least-developed countries remain outside is explained by their little participation in the recent economic globalization.

What, then, should be the priority for international coordination on technology diffusion in the future? In the case of emerging economies, there is no reason to think that they will not continue to effectively absorb foreign technologies. In this group, certain laggards – south Asia and India in particular – will benefit from a growing participation in economic globalization. This suggests a limited role for the Technology Mechanism which should essentially provide local private and public actors with information to facilitate coordination (e.g. through technology needs assessment) and to assist them when moving towards the international regulation of market mechanisms – in particular, trade rules and Intellectual Property – from the World Trade Organization to the UNFCCC.

The situation of least-developed countries is paradoxical. On the one hand, it is most interested in green technologies; on the other hand, there is less urgency to deal with the problem as their contribution to global emissions will remain limited in the near future. In this group, the priority is to build technological capacities and to promote their integration into the global economy. In fact, the problem to be solved is very general: the economic under-development of certain countries and regions, in particular in Africa. We believe that the UNFCCC might not be the adequate forum to deal with what, essentially, appears as a development issue rather than a climate change-related problem.

O-3315-04

The role of public-private partnerships in energy innovation and technology development

I. Azevedo (1) ; I. Azevedo (2)

(1) Carnegie Mellon University, Engineering and Public Policy, Pittsburgh, PA, United States of America; (2) Carnegie–Mellon University, Department of engineering and public policy, Pittsburgh, United States of America
In order to transition to a low carbon, sustainable, energy system globally and avoid potentially dramatic effects from climate change, the work needs to reduce greenhouse gas emissions by roughly an order of magnitude.

Existing technologies and strategies, such as using energy more efficiently, scaling up of renewables, the use of nuclear and a short-term transition to natural (ensuring low leakage rates), and deployment of carbon capture and sequestration will be necessary to help with such transition.

However, there is a continuous need for innovation to help achieve these goals at lower costs. This brings us to a conundrum: the returns on public and private R&D investments and other policies (such as a carbon price or tax, production tax credits, feed-in tariffs, among others) that may lead to energy innovations and help curb the costs of climate mitigation strategies are multifaceted uncertainty problems. Namely, uncertainty arises regarding 1) what will be the outcomes in terms of technology breakthroughs or improvements associated with R&D investments or other policy mechanisms that are implemented to promote innovation? 2) when will these technology breakthroughs or improvements occur and how to deal with the uncertainty regarding the timeline of such improvements? 3) if these breakthroughs or improvements occur, how fast or slow will the diffusion process be across different regions?

To address this issues requires both retrospective assessments of what outcomes have different policies and R&D investments delivered so far, as well as a forward looking perspective to enable us to make decisions for climate and energy decision under deep uncertainty.

In this talk, I will start with a retrospective analysis with the objective to derive from the literature regard the outcomes of R&D investments and other policies on technology innovation and deployment in several regions of the world. In particular, I will provide examples regarding the Advanced Research Projects Agency-Energy (ARPA-E) program, the production tax credits and the renewable portfolio standard in the United States, and regarding the feed-in tariffs (and other similar policies) in many of the European Union countries, and finally assessing also the outcomes of incentives provided to wind and solar innovators in China.

While understanding the outcomes of previous policies on innovation is already a challenging task, a forward looking assessment is an even more daunting and humbling exercise: forecasts of how the energy system is likely to be shaped in the future has been proven to be quite poor, and any decision framework will be plagued by deep uncertainty. I will outline a methods that provides insight on how to develop forecasts for energy technology, prices, and suggest a framework on how this information could be used to help identify the needs for investment in energy RD&D and to avoid “dead ends”; identify investment priorities and methods for establishing them; and consider what institutional frameworks and policy instruments will be most conducive to innovation that will help the achievement of a low-carbon transition.

Interrogating the transformative power of renewable energy support instruments: the example of feed-in tariffs on photovoltaics

B. Cointe (1)
(1) CIRED, Nogent sur Marne, France

The deployment of renewable energy is considered to be a crucial part of mitigation strategies, and its promotion on the policy agenda has been largely driven by concerns related to climate change, pollution of the environment and improved social acceptance levels fundamental to the deployment of renewable energy technology.

However, the transformations triggered by such instruments do not exactly conform to expectations: feed-in tariffs have driven the deployment of markets for electricity from renewable energy sources and the increase in renewable energy installed capacity, but they have also had many unintended effects and consequences that had to be addressed ‘on the go’. The difficulties in managing the dynamics triggered by such mechanisms are especially striking in the case of photovoltaics, which have developed at a dramatic pace and led to political reforms and crises of varying intensities in several countries (e.g. France, Germany, Spain, UK…). Feed-in tariffs, it turns out, transform not only markets and technologies, but society and politics as well. This contribution will attempt to conceptualise the transformative power of such instruments and the issues related to its management by suggesting an alternative account of the functioning and effects of feed-in tariffs for photovoltaics.

To this end, it will rely on actor-network theory research on market-making and politicalisation and on studies on governmentality. From this theoretical perspective, it will explore FIT-driven photovoltaics development in three sites, each of which sheds light on specific aspects and tensions of feed-in tariffs for photovoltaic electricity understood as political: the emergence and institutionalisation of feed-in tariffs for photovoltaics in the context of European renewable energy policy, the overflowing of the photovoltaic market that they provoked and the political crisis that ensued in France between 2009 and 2012, and the way in which they have indeed proved effective in attracting investment towards renewable energy technologies, especially wind power and photovoltaics.

ABSTRACT BOOK
International Scientific Conference     7-10 JULY 2015    PARIS, FRANCE
P-3315-04

Dew collection for water supply in Valparaíso, Chile

D. Carvajal (1); D. Araya Muñoz (2); N. Guajardo Ramírez (1); C. Carlesi Jara (1)
(1) Universidad Católica de Valparaíso, Escuela de ingeniería química, Valparaíso, Chile; (2) University of Edinburgh, School of geosciences, Edinburgh, United Kingdom

The availability of fresh water has become a serious problem in arid and semiarid areas of the world. There are large areas in the world, mainly in arid or semi-arid climate, with chronic shortages of fresh water, which has been aggravated consequence of climate change, population growth and, agricultural and industrial activities. As the demand for water increases constantly growing areas that historically had no problems with availability of fresh water, have become areas with intermittent water shortages or even permanent. The problem of water shortage in Chile has been accentuated in the north and increasingly in the central area, affected by the intensive use of water in agriculture mainly. As a consequence of the problem of water scarcity, various technologies have been deployed focusing to capture only fresh water from conventional sources such as rivers or groundwater, but also unconventional sources such as seawater treatment through processes such as distillation, reverse osmosis or thermal-electro-dialysis, to recover water from the atmosphere as is the case of fog precipitation and dew collection based on radiative cooling.

Dew formation by radiative cooling occurs when a solid surface radiates heat into sky causing its temperature becomes lower than the dew point of the water vapor contained in the surrounding air, causing condensation (liquid water). This condition usually occurs during cool nights with high relative humidity, low cloud cover and moderate or low wind speed. Once the condensation process occurs, the liquid water may be collected by natural drainage on an inclined surface (by gravity) and then stored in tanks. The water produced by the system may have uses such as irrigation or human consumption (pre purification treatment if necessary).

This work aims to assess experimentally the dew water collection based on radiative cooling using galvanized steel sheets as radiative surface. Experimental tests were carried out in the city of Valparaíso, which is located in the central coast of Chile. The amount of dew water produced was experimentally quantified, and the quality of dew water produced was also analysed. The testing location included five experimental units (modules), each of which consist of galvanized steel sheets with zinc-aluminum, supported by a steel frame. Each sheet was thermally coated with its back by Sytrofoam. The sheets were coated with a paint containing an additive infra-red emitting minerals (TiO2 and BaSO4) in the atmospheric window, and a non-soluble surfactant that render the surface more hydrophobic by SPIR. An experimental campaign with a total duration of 30 days was carried out.

The results indicated the following: the collectors produced amounts of dew between 0 and 89 ml/m² per night, and the analysis of dew water showed alkaline pH for all samples which may be due to the proximity of the ocean. Weather station measurements indicated significant changes in several atmospheric parameters on daily as well as hourly basis, including humidity and wind speed which could explain the variability of the amount of dew obtained. The next steps in this project include; chemical and biological analysis to determine whether dew water is potable and an analysis of spatial and temporal temperature in the collectors and a test campaign of one year to determine the seasonal variability of dew yield in the study area.

Acknowledgments
This work was supported by Fondecyt N° 11140863 project from CONICYT (Chile) and DI 37.0/2014 project from the Universidad Católica de Valparaíso (Chile).

P-3315-05

ABSTRACT BOOK
International Scientific Conference     7-10 JULY 2015    PARIS, FRANCE

Communities generally perceive socioeconomic benefits accruing from market-oriented structures are preferable to corporate structures, yet lack supporting quantitative data to inform energy policy. This study uses the Everpower wind development, to be located in Michigan, to examine hourly, diurnal and seasonal patterns of wind speed to identify and examine socioeconomic impact trends arising from corporate, community and diversified funding structures. Analysis of five National Renewable Energy Laboratory (NREL) Pros and Economic Development Impact models incorporating local economic data and review of relevant literature were conducted. The findings suggest that community and diversified funding structures exhibit 40-100% higher socioeconomic impact levels than corporate structures. Prioritization of funding sources and retention of federal tax incentives were identified as key elements. The incorporation of local shares was found to mitigate negative effects of foreign private capital, and local debt financing increased economic output and opportunities for private equity investment were identified. The results provide the groundwork for energy policies focused to maximize socioeconomic impacts, while creating opportunities for inclusive economic participation and improved social acceptance levels fundamental to the deployment of renewable energy technology.
will also contribute to the analysis of the implications and challenges of implementing the policy through the creation and engineering of new markets that seems to characterise many climate policies.

P-3315-06
The role of public-private partnerships in energy innovation and technology development

J. Coleman (1)
(1) Energy Technologies Institute, Strategy, Loughborough, United Kingdom

Innovation is key to delivering an affordable and secure low carbon energy system. There is no time to invent and develop a whole range of new breakthrough technologies and the cost of adaptation will inevitably be higher than the cost of mitigation. So, whilst breakthroughs will always be welcome we cannot wait on them and neither can we do so alone. A transition will need to be enabled by developing, commercialising and integrating known but currently underdeveloped solutions.

This means that the emphasis of technology innovation shifts from basic research and development towards scaling up, demonstration, early deployment and systems integration to prove and improve performance, drive down cost and build developer and investor confidence.

This scaling up of known but underdeveloped technologies involves different challenges and risks to earlier stage R&D and requires different skills to deliver it as well as an increase in funding levels. In a world with a functioning carbon market providing clear market signals public sector investment in early stage R&D should leverage investment from the private sector to further develop and deploy the most promising technologies. However, given the long lead times and high capital costs for many energy technologies even with a functioning market, there is potentially a significant valley of death in which the risk/reward balance remains insufficient to attract the levels of finance needed for demonstration and early scale deployment.

Current market structures and carbon pricing appear unlikely to provide a sufficient market signal to incentivise the private sector alone to deliver the level of change needed in the timeframe required. In fact the lack of a carbon price in many ways reinforces the somewhat pessimistic view from many of the larger companies in the technology sector that there is insufficient policy and public and co-ordination to contain global warming to 2degC, even though it is technically feasible and affordable to do so. Current policies, economic drivers and the risk of renewables do not necessarily contain substantial private sector investment in improving the efficiency and performance of incumbent technologies but this alone is insufficient. Scale and transition need an alternative is increased government-led support with penalties and incentives tailored to each sector, such as the Contracts for Difference introduced in the UK’s Electricity Market reform, to deliver a ‘policy pull’ until a carbon market is established. This approach is not without its challenges; not least the need to award Contracts through a transparent and competitive process in a particular challenge is in evaluating the value of programmes in terms of their long term contribution to decarbonising the energy system. Given the short term nature of the policy mechanism it also doesn’t adequately address the valley of death for some of the large scale technology and infrastructure developments that are potentially key to an affordable transition. Moreover, private sector organisations tend to be focussed on a particular sector (or component of a sector) of the energy landscape whilst the public sector needs to integrate and assess priorities across and between sectors.

A successful transition requires the free markets efficient allocation of resources, innovation and deep technical skills to be combined with the governments ability to prioritise between sectors, its access to low cost of capital, demonstration, regulatory and policy innovation and investment role. Without a functioning carbon market (and probably even with it) the public sector plays an essential role in providing long term funding and taking much of the risk in demonstration and early deployment of key technologies. However to be successful this must leverage financing and draw on the skills of the private sector. The UK’s experience suggests that working in partnerships is a way to combine these elements that the public and private sectors need to bring to a successful transition.

Key references:
Coleman, J. and Haslett, A. 2015. Targets, technologies, infrastructure and investments – preparing the UK for the energy transition.

P-3315-07
LIFE programme and Climate Change

P. Fetsis (1)
(1) Neemo EEIC / AEIDL, LIFE communications team, Brussels, France

The LIFE programme was established in 1992 and is the EU’s funding instrument for the environment. The general objective of LIFE is to contribute to the implementation, updating and development of EU environmental policy and legislation by co-financing pilot or demonstration projects with added value.

With 4171 initiatives supported to date, LIFE has improved the environmental performance of a wide range of sectors and fields across Europe. Pressure on water resources is being exacerbated by climate change. LIFE projects have focused on tackling water scarcity and natural water hazards, both in urban and rural contexts. Optimisation of water use through innovative water management infrastructure, water resource planning and allocation modelling, techniques for groundwater storage improvement, cost analysis and water pricing services are amongst the practices developed and tested when addressing the impact of climate change on floods, as well as on supply and availability of water.

Below you can find some examples of LIFE projects on specific themes:

Europe, flood risk management

Floodscan: The project aimed to limit flood risk by testing an innovative and cost-effective method of mapping flood hazard areas. A web mapping service was developed to provide reliable and accurate information about flood risk not only for the general public and businesses but also for local and regional authorities, enabling them to take more effective planning decisions (e.g. to ban building in certain areas).

HydroClimateStrategyRiga: The project aimed to create a flood risk management plan for the city of Riga in order to create the means necessary to ensure that hydrological processes intensified by climate change phenomena are adequately investigated and incorporated into the city’s planning system. Methodological guidelines were developed, based on existing and future flooding trends in Riga and reinforced by best practices in the identification, planning and management of flood risk zones as adopted in Rotterdam, Antwerp and Hamburg.

Mediterranean Basin / Innovation, Technology deployment & policies

Water Agenda: The main objective was to apply the Water Framework Directive principles and guidelines in order to reverse water degradation levels in the Anthemius river basin, in Greece. A sustainable water resource management policy was developed and agreed amongst locals, demonstrating adequate social, technical, administrative and economic techniques and tools (e.g. allocation of water, real-time cost/benefit data, water pricing), mainly focusing on how to address water quantity/quality problems according to the region’s development trends, natural and social characteristics.

WIZ: Developed and demonstrated an innovative online platform that includes two informative services (WIZ4All & WIZ4Planners), able to incorporate the protection and sustainable management of water in urban planning processes and local policy areas. An analysis of long-term management of drinking water integrated into land use planning was conducted, enabling water authorities to prepare investment plans and harmonize data characterising the water demands of an area. Information on water resources availability based on the effects of
climate change or active reporting on the quality of drinking water are amongst the activities making an optimum ‘participatory management approach’ possible.

P-3315-08

Lost at sea? Charting wave energy's difficult journey towards commercialisation since a resurgence in UK government support

M. Hannon (1)
(1) Imperial College, Centre for Environmental Policy, London, United Kingdom

Large-scale support for wave energy innovation in the UK can be traced back to the early 1970s, a momentum triggered by a sharp rise in fossil fuel prices following the oil crisis (Mukora et al. 2008). During this time wave energy became the principal focus for public research, development and deployment (RD&D) funding for renewable energies. However, as oil prices fell and the UK became a net exporter of oil during the 1980s and 90s, funding began to decline rapidly. This shift is embodied by the termination of the UK’s Wave Energy Programme in 1982, which was discontinued on the basis that official government estimates projected that wave energy would be more expensive in the long run compared to other promising (e.g. wind, nuclear) and established (e.g. coal) sources of energy (Ross 1996).

It wasn’t until the late 1990s and early 2000s that ocean energy enjoyed a renaissance on the basis that UK governments believed it could make the right contribution to reducing its carbon emissions reduction targets, whilst at the same time stimulating economic growth (LCICG 2012; Jeffrey et al. 2013; RCEP 2014). Subsequently, £150 million of UK public funding was committed to ocean energy RD&D since 2000. However, despite this resurgence in support there are still no commercial wave energy devices operating in UK waters today, with no major roll-out of devices expected until at least the 2020s (LCICG 2012).

In this context the presentation explores why wave energy technology has failed to reach commercialisation in the UK despite a rich history of wave energy RD&D and a recent resurgence in public RD&D support since the turn of the millennium. It takes a detailed look at what have been the subsequent successes and failures during this period and which factors have been responsible. To answer these questions the presentation draws upon a combination of qualitative (i.e. interviews, documentary analysis) and quantitative (i.e. IEA RD&D repository) analysis to provide evidence. Some recommendations are presented to inform the design of the UK government’s energy and innovation policy, with a view to accelerate the development and deployment of low-carbon technologies and help it meet its carbon emissions targets.

References


P-3315-09

Device of dew and rain collectors in Guéné, Northern Benin

G. Koto N’gobi (1)
(1) Abomey-Calavi University, Physic department, Cotonou, Benin

Dew phenomenon is a process where water vapor condenses on various types of surfaces, such as grass, crops, roofs or vehicles which are daily exposed during changing climate. It occurs at night or early in the morning, when nocturnal radiative cooling leads to surface temperature decrease, and humid air nearby the surface condenses as its temperature falls down below the dew point temperature of the surrounding atmosphere. Dew is important in several domains and has been the focal point of various scientific researches during many years. Its ecological and social importance has been shown in arid and semi-arid areas or islands. A condenser is a surface on which dew can condense on. Three main geometrical shapes of condensers are generally presented: flat condensers, conical condensers and truncated condensers. Guéné is a semi-arid village in northern Benin with hard scarce drought conditions. The objective of this work is to present the different phases of making a truncated dew condenser, using local materials in order to pull benefit from dew water as an alternative source of water to adapt to climate severe conditions in Guéné. A device of rain water collector combined with the truncated condenser increase the amount of water that can be mobilized. During 62 days of measurements, 44 dew events and 5 rain events were observed. The results show that: (i) the truncated condenser can collect about 166 liters, which represent about 2.7L per night, or 3.77L per dew night (ii) until 10 m3 of rain water can be stocked during the rainy season, (iii) dew amount represents about 36% of the total rain amount during dew period. The collected dew and rain water represent the only source of water used in Guéné primary School for daily academic activities.

P-3315-10

The role of innovation and deployment policy mixes for innovation in renewable power generation technologies: a survey analysis of German technology providers

K. Rogge (1); J. Schleich, (2)
(1) Fraunhofer ISI / University of Sussex, Energy policy and energy markets / spru- science policy research unit, Karlsruhe, Germany; (2) Fraunhofer ISI / Grenoble Ecole de Management, Energy policy and energy markets, Karlsruhe, Germany

The decarbonization of energy systems constitutes one of this century’s key challenges for human society in the fight against climate change (van Vuuren et al 2013). In such a transition to low-carbon solutions (rogge and reichardt 2013). Yet precisely how policy mixes affect technological innovation remains poorly understood. rather, studies so far have focused on the impact of single policy instruments on environmental innovations, and also on their stringency as one of their design features (Kemp and Pontoglio 2011). However, in reality complex policy mixes are at play, implying that studies should focus on the interaction of policy instruments (Flanagan et al. 2011) and on overarching characteristics of such policy mixes, such as their consistency (Rogge and Reichardt 2013).

We address this gap in the literature by studying the case of the German Energiewende. More precisely, we analyse the role of the policy mix for firm level innovation activities in renewable power generation technologies within the German power sector. Since this sector is supplier-driven (Pavitt 1984) we focus on German technology providers, and extend existing qualitative work in the sector (rogge et al. 2011, Hoppmann et al. 2013) by conducting a survey of companies’ innovation activities. The questionnaire for this survey was designed in line with the Community Innovation Survey, but adjusted to the context of renewable power generation technologies and extended by a number of questions on companies’ perceptions of the policy mix. The survey was conducted by telephone from April 9 until June 22, 2014, with interviews lasting around 30 minutes. In this time period we contacted all German renewable power generation manufacturers and suppliers and achieved a response rate of approximately 36% (n=390).

In our econometric approach we employed a bivariate Tobit model to estimate R&D expenditure equations for the years 2014 and 2015, where the error terms captured possible
correlations between R&D expenditures in different years. In this case, the use of univariate Tobit probit models can lead to biased and inconsistent parameter estimations (e.g., Greene, 2012). The simulated maximum likelihood estimations were carried out with STATA 13, relying on Barslund (2009).

Findings of our econometric analysis suggest that R&D expenditures in both years are larger for companies with higher current and previous R&D expenditures (i.e., R&D investment in the respective renewable power generation technology, which is in line with other studies on the key relevance of domestic and foreign demand pull instruments (Peters et al. 2013). Likewise, higher R&D expenditures are positively related to the amount of subsidies received for R&D from German or EU public funding bodies, thereby confirming the importance of technology push instruments for innovation. Further, future R&D spendings are larger if respondents perceive the current instrument mix to be consistent in its support of renewable energy, and if they perceive a high credibility of the overarching policy mix, as measured by the cross-party support for the expansion of renewables within the German Energiewende. This confirms and extends qualitative findings for offshore wind in Germany pointing to the importance of policy mix in promoting innovation activities of domestic manufacturers in renewable power generation technologies. Such support enables them to build-up and strengthen their industries and the global deployment of innovative low-carbon technologies, thereby contributing to mitigating global climate change.

Based on our findings we derive recommendations for policy makers on how to tailor policy mixes to support innovation in low-carbon technologies. These policy implications are not only relevant in the context of the German Energiewende but for any country aiming to promote innovation activities of domestic manufacturers in renewable power generation technologies. The impact on peak loadings is particularly important, since occasions of extreme temperatures are likely to stress electricity systems in meeting demand (Parkpoom & Harrison, 2008). The Model for Energy Supply Scheduling and Planning (MESSE) is a powerful tool for assessment of economic load flow operations (Chowdhury & Crossley, 2009). MESSAGE is used to simulate different daily load profile and thus power output can be evaluated for both centralized generation and distributed generation.

Peak demand fluctuations may occur on daily, weekly, monthly, seasonal and yearly cycles. Different power system or different categories of consumers (Residential, Industrial and Commercial) can have similar or distinct daily demand curves. Daily load profile shape has a significant influence on power dispatch and thus, during the peak hours most of power plants need to run on their maximum load. Since peak power plants are in most case fossil fuel power plants due to their operation costs, it can be assumed that the need of covering peak demand contribute to aggravate CO2 emission. The shape of the daily load profile is associated with plant capacity factor. High plant capacity factor leads to increase of power production.

Plant capacity factor = (Average annual Output/Plant capacity x 8760)

In order to avoid peak demand, different measures can be implemented (energy efficiency, micro-grid system, renewable technologies etc.). According to IEA (2007), micro grid systems show strong potential to optimize asset utilization by shifting peak load to off-peak times, thereby decoupling electricity growth from peak load growth. Apart from this advantage, micro grid systems improve power quality and reliability due to decentralization of supply and demand. Economic operation of micro grid systems should be ensured through generation scheduling, economic load dispatch and optimal power flow operations (Chowdhury & Crossley, 2009). MESSAGE is a powerful tool for assessment of economic load dispatch and optimal power flow operations. For example, considering that renewable technologies such as solar PV and wind power plants are no dispatchable, connecting them off-grid can make those technologies competitive with other dispatchable technologies such as gas and coal power plants.

References:
Fathi, M.; Bevrani, H. Adaptive energy consumption scheduling for connected microgrids under demand uncertainty.
Khodayar, M.E.; Barati, M.; Shahidehpour, M. Integration of high reliability distribution system in microgrid operation.

The role of micro-grid on decoupling sharp fluctuations of electricity demand
P. Roque (1); S. Chowdhury, (2)
(1) Eduardo Mondlane University, Mechanical Engineering, Maputo, Mozambique; (2) Tshwane University of Technology, Electrical engineering, Pretoria, South Africa

Among the many human activities that produce greenhouse gases, the use of energy represents by far the largest source of emissions (IEA, 2014). This paper presents key relationships that show electricity demand fluctuations have with CO2 emissions and describe how the shape of fluctuations interact with power dispatch, contributing to increase greenhouse gases that influence climate change. The impact of peak loadings is particularly important, since occasions of extreme temperatures are likely to stress electricity systems in meeting demand (Parkpoom & Harrison, 2008). The Model for Energy Supply Scheduling and Planning (MESSE) is used to simulate different daily load profile and thus power output can be evaluated for both centralized generation and distributed generation.

Peak demand fluctuations may occur on daily, weekly, monthly, seasonal and yearly cycles. Different power system or different categories of consumers (Residential, Industrial and Commercial) can have similar or distinct daily demand curves. Daily load profile shape has a significant influence on power dispatch and thus, during the peak hours most of power plants need to run on their maximum load. Since peak power plants are in most case fossil fuel power plants due to their operation costs, it can be assumed that the need of covering peak demand contribute to aggravate CO2 emission. The shape of the daily load profile is associated with plant capacity factor. High plant capacity factor leads to increase of power production.

Plant capacity factor = (Average annual Output/Plant capacity x 8760)

In order to avoid peak demand, different measures can be implemented (energy efficiency, micro-grid system, renewable technologies etc.). According to IEA (2007), micro grid systems show strong potential to optimize asset utilization by shifting peak load to off-peak times, thereby decoupling electricity growth from peak load growth. Apart from this advantage, micro grid systems improve power quality and reliability due to decentralization of supply and demand. Economic operation of micro grid systems should be ensured through generation scheduling, economic load dispatch and optimal power flow operations (Chowdhury & Crossley, 2009). MESSAGE is a powerful tool for assessment of economic load dispatch and optimal power flow operations. For example, considering that renewable technologies such as solar PV and wind power plants are no dispatchable, connecting them off-grid can make those technologies competitive with other dispatchable technologies such as gas and coal power plants.

References:
Fathi, M.; Bevrani, H. Adaptive energy consumption scheduling for connected microgrids under demand uncertainty.
Khodayar, M.E.; Barati, M.; Shahidehpour, M. Integration of high reliability distribution system in microgrid operation.

Resource-Policy-Innovation Nexus for Entrepreneurial Roles across Scales and Sectors of Low Carbon Pathway in Climate Governance
A. Tiwari (1)
(1) National Institute Of Technology, NITB, India

In the next 25 years, the world needs to invest 40 trillion dollars in infrastructure modernization. It is important to ensure that these financial resources are invested in low-carbon technology instead of conventional carbon-dependent systems. For developed economies where investments will mainly involve replacing out-of-date technology, the transition to a climate-friendly society will involve replacing existing fossil intensive systems. For developing economies, the transition to a larger extent concerns changing the course for implementing new energy systems. This brings opportunities and challenges for sustainability entrepreneurs. Nations not yet subject to fossil technology and institutional lock-in could potentially skip certain development stages (such as the fossil era), thus “leap-frogging” into the new low-carbon economy. Indeed, fast–growing economies will have to leapfrog past much fossil technology, or we will not be able to meet the climate challenge.

The study outlines the essential role of entrepreneurs to operate within resources unaccounted for effects, within which they find opportunities to create value. These efforts are often easier when property rights and legal rules are clearer. Challenges to environmental entrepreneurs include environmental problems that cross international boundaries—the transaction costs and financial resource institution of dealing in different legal structures and
property rights systems are huge. As this space for environmental entrepreneurship based on property rights and win-win outcomes shrinks, the space for political entrepreneurship expands. One form of political entrepreneurship is alertness to previously unnoticed rent-seeking opportunities. Cross-country evidence shows, for example, that the uncertainty generated by the cross-boundary environmental issues are characterized by more than usual actions by political entrepreneurs. An example is the potential for climate change caused by human producers of greenhouse gas emissions. Agnolucci (2006) shows how the introduction of a biennial revision of feed-in-tariffs in Germany through a modification of the Renewable Energy Act (EEG) may cause significant uncertainty. While raising the results achieved by the German renewable energy policy, he demonstrates that political uncertainty was behind the decrease in the-time period of the German renewable energy policy. The uncertainty surrounding policy may be a strong determinant of the development of renewable energy supply. However, a major limitation in the existing academic literature on climate change and energy policy shows that less attention has traditionally been devoted to its impacts than to those of economic or technological uncertainty. Moreover, most of the discussion is considered to be theoretical. This is a major shortcoming, as policy making and design should be informed about the negative impact on private investors decisions of changing rules, conditions, and the like in an environment of being able to provide a sufficiently stable policy environment.

This paper attempts to bridge a gap in the empirical literature and provide policy-relevant insight on the impact of uncertainty on wind innovation in 18 European countries over the years 1995–2009. We go a long way towards constructing sound empirical proxies for environmental policy stringency and policy uncertainty. Inspired by the real option theory, we propose two novel proxies, one for environmental policy stringency and one for the uncertainty arising from such policy. Unlike those used in previous studies on renewable energy technologies, our proxies for policy stringency and policy volatility are robust to three major concerns. First, we net out the effects of those non-policy factors which might drive capacity addition on top of government policies. Second, our proxies account for the fact that rational investors refer to expected policy and policy changes, not merely current capacity additions rather than current ones, to make their decisions. Finally, and more fundamentally, we clean our proxies from the issue of potential reverse causality between installed capacity (and its volatility) and innovation. More specifically, we control for the fact that innovation may stimulate capacity additions through technology improvements resulting in greater efficiency and/or lower costs.

We confirm the positive inducement effect of environmental policy on innovation and most importantly show that indeed policy uncertainty counters such positive effect. We find that if the negative impact of uncertainty is due to one standard deviation in the sample, the benefits to innovation due to the increased stringency level are wiped away due to the negative effect of policy uncertainty.

P-3315-13

The impact of policy and uncertainty on innovation in the wind industry: evidence from European countries

E. Verdolini (1) ; V. Bosetti (2) ; P. Jockers, (3)

(1) FEEM Fondazione Eni Enrico Mattei, CCSD, Milan, Italy;
(2) Fondazione Eni Enrico Mattei, Milan, Italy;
(3) Bocconi University, Milan, Italy

The 2010 moratorium on the level of feed-in-tariffs in the French solar photovoltaic industry offers one of the best illustrations to existing technologies and systems, which hinder transition to the low-carbon economy by the fact that carbon emitting technology does not carry its full climate cost, or that innovations typically require higher upfront investment than fossil intensive systems, while subsequent costs for operations are lower, and due to which short-sighted financial analyses favour fossil intensive systems. In this context, the research allows for collaborative rather than unilateral effectiveness to be higher than the sum of individual roles in administering linear resource flows with input, process, and waste that will be replaced by cyclical flows. The outcomes favour entrepreneurial roles in dynamic interplay between nonstate, or subnational, and/or lower costs.

This is one of many examples highlighting the negative impact of policy uncertainty, namely of uncertainty arising from policy change and complexity. Similar anecdotal evidence and case studies can be found in the academic literature on innovation, renewable energy, and the like. For instance, Barradale (2010) describes how chronic uncertainty over the renewal of the production tax credit in the U.S. has been driving investment volatility. Meyer (2006) shows how the introduction of the Renewable Energy Act (EEG) in Denmark has generated uncertainty for investors. Agnolucci (2006) shows how the introduction of a biennial revision of feed-in-tariffs in Germany through a modification of the Renewable Energy Act (EEG) may cause significant uncertainty. While raising the results achieved by the German renewable energy policy, he demonstrates that political uncertainty was behind the decrease in the-time period of the German renewable energy policy. The uncertainty surrounding policy may be a strong determinant of the development of renewable energy supply. However, a major limitation in the existing academic literature on climate change and energy policy shows that less attention has traditionally been devoted to its impacts than to those of economic or technological uncertainty. Moreover, most of the discussion is considered to be theoretical. This is a major shortcoming, as policy making and design should be informed about the negative impact on private investors decisions of changing rules, conditions, and the like in an environment of being able to provide a sufficiently stable policy environment.

This paper attempts to bridge a gap in the empirical literature and provide policy-relevant insight on the impact of uncertainty on wind innovation in 18 European countries over the years 1995–2009. We go a long way towards constructing sound empirical proxies for environmental policy stringency and policy uncertainty. Inspired by the real option theory, we propose two novel proxies, one for environmental policy stringency and one for the uncertainty arising from such policy. Unlike those used in previous studies on renewable energy technologies, our proxies for policy stringency and policy volatility are robust to three major concerns. First, we net out the effects of those non-policy factors which might drive capacity addition on top of government policies. Second, our proxies account for the fact that rational investors refer to expected policy and policy changes, not merely current capacity additions rather than current ones, to make their decisions. Finally, and more fundamentally, we clean our proxies from the issue of potential reverse causality between installed capacity (and its volatility) and innovation. More specifically, we control for the fact that innovation may stimulate capacity additions through technology improvements resulting in greater efficiency and/or lower costs.

We confirm the positive inducement effect of environmental policy on innovation and most importantly show that indeed policy uncertainty counters such positive effect. We find that if the negative impact of uncertainty is due to one standard deviation in the sample, the benefits to innovation due to the increased stringency level are wiped away due to the negative effect of policy uncertainty.

P-3315-14

Scaling up technology transfer through the UNFCCC Technology Mechanism

K. Wada (1)

(1) RITE, Systems Analysis Group, Kyoto, Japan

This paper contributes to debates about technology transfer through the UNFCCC Technology Mechanism for climate change mitigation and adaptation. The purpose of this study is to understand the challenges that the current UNFCCC approach faces and to make policy recommendations on how the UN process can be brought closer to the actual need of technology to address climate change. This analysis is relevant to international negotiation in the post-2020 climate regime.

The mechanism has played a limited role in technology transfer so far, failing to materialize in actual technology deployment. Technologies can be transferred through various channels, ranging from official development assistance (ODA) to private economic activities, such as foreign direct investment (FDI). The UNFCCC, however, deals with technology transfer, as a government-to-government process and disvalues the role of private sector. This narrow focus cannot deliver a significant level of low-carbon technology required to curb GHG emissions in developing countries.

There are number of reasons why the UNFCCC needs to structureize business activities, rather than governmental support, as a basis of technology transfer. First of all, the private sector owns most of the low-carbon technologies. Without their engagement and innovative capability, the existing UNFCCC process will not deliver the scale of change that is necessary to achieve climate goals. The carbon credits via the CDM have facilitated private sector investments.
The Technology Mechanism established in 2010 can be a potential platform to bring the UNFCCC process closer to stakeholders such that they can influence sector investment. The Technology Executive Committee (TEC), together with the Climate Technology Centre and Network (CTCN), is mandated to facilitate the effective implementation of technology transfer. The CTCN strives to stimulate technology cooperation and to enhance climate technology development and transfer. CTCN operations are supposed to be conducted via partner institutions with expertise in climate technologies with an international network of academic, finance, NGO, private and public sector institutions. National Designated Entities (NDES) are also nominated as national CTCN focal points to coordinate and submit technical assistance requests to the CTCN.

Technology has rarely been transferred explicitly yet through this premature mechanism. Hence, I would propose three specific ideas to enhance the mechanism. First, the CTCN, whose current network members are mostly private entities, distribution needs to include private firms that have technology solutions and financial sector, such as regional development bank, to harnesses more private sector investment. Secondly, the function of NDES in developing country needs to be expanded. The present role of NDES is limited to a focal point to their technology needs to the CTCN, but it can be strengthened as a liaison between local technology needs and opportunities helping to create enabling environments that facilitate private investment. Finally, linkages between the Technology Mechanism and the Financial Mechanism of the Convention is necessary to provide grants to developing countries for the support of capacity building or adaptation technology, which are usually not covered by business activities. This item was negotiated in COP20 but the parties were unable to reach agreement, and discussed again in COP 21. The link between the two mechanisms and enhancement of the private sector involvement would be drivers of scaling up technology transfer.

University-Industry-Government Collaboration for Innovation to Tackle Sustainability Challenges: Functions and Mechanisms of Stakeholder Platforms on Smart Cities

M. Yarime (1)
(1) University of Tokyo, Graduate School of Public Policy, Tokyo, Japan

Many countries have introduced policies to encourage innovation through technology transfer academia to the private sector, often with exclusive agreements on intellectual property rights. While some successful cases have been reported in transforming knowledge created by universities into products, innovative platforms and existing models of university—industry—government collaboration tend to focus on narrowly-defined technical issues, mainly targeted to commercial applications. For technology leadership the current collaboration design will not be required to promote innovation, involving a wider variety of stakeholders with more diverse knowledge and expertise in scientific and technological fields. Smart cities and communities are particularly considered to be one of the key areas in which a variety of science and technological knowledge need to be integrated effectively through collaboration among many actors. A smart city integrates a diverse mixture of hardware as well as software in a complex way, different approaches would be possible to introducing and implementing the concept of smart cities in practice, depending on the economic, social, and environmental conditions and purposes, such as energy efficiency, operating cost, environmental impact, resilience to external shocks and disturbances, and accessibility and inclusiveness to end users.

Recently, leading research universities around the world have started to emphasize the need for new forms of engagement in order to address societal challenges. These include the creation of future visions based on science, setting of concrete and practical goals and targets, joint scenario making with stakeholders, securing active participation and serious engagement of stakeholders, collection and analysis of data on societal needs and demands, development of new technologies and systems through social experimentation at universities as living laboratories, assessment of impacts with transparency, objectivity, neutrality, legitimation of innovation in society, provision of effective feedback to academia, institutional design, and contribution to agenda setting at regional, national, and global levels. On the other hand, difference are also found with regard to the direction and priorities of technology development, science and innovation between Japan, Europe, and the United States. The Japanese approach is characterized by a strong focus on social and applied skills and capabilities for application of extensive use of home appliance and electric vehicles.

In Europe an emphasis is placed on establishing a basic infrastructure in which information about the behavior of all the stakeholders is collected and distributed among the stakeholders appropriately so that the various objectives of the electricity grid are achieved in a more equitable way. In the United States a strong interest can be observed in creating and maintaining secure skills and capabilities for resilience in unemployment against physical as well as virtual threats.

These asymmetries in conceptualizing and implementing smart cities reflect the differences in how knowledge development, stakeholder networks, and institutional environment interact in dynamic and systemic manners. The cases highlighted in this paper provide valuable insights into potential ways forward for collaboratively designing and creating knowledge and implementing innovation to tackle sustainability challenges. For follow-up efforts and new projects in the future, however, we still need deal with remaining challenges, including how to navigate the differing motivations and incentives, serious engagement and fruitful collaboration among the various actors, to promote joint initiatives and networking that contribute to achieving desirable goals and targets and developing long-term strategies for the future, to identify the factors and conditions required to promote their successful implementation.

Re-engineering a Flood Control in Jakarta as a capital city of Indonesia

SA. Yusuf (1)
(1) Universite Bordeaux1, Enterprise Engineering, Jakarta, Indonesia

Background: Without an integrated system and good infrastructure, life in Jakarta is problematic and “not of quality”, these implies inconsistent in various aspects. The aversion of the government and company to invite along experts from Universities to optimize the system of flood control as a capital city is also an obstacle. However the need of research to solve these problems is urgently necessary, because now Jakarta attracts more investors from abroad and domestic where Jakarta is the center of all business. Therefore a good infrastructure that guarantee safety, comfort and health can boost the condition by giving the effectiveness, efficiency and also its quality.

Project: The paper is done by following the estimation of design flood and the control for 3 months by observing several values for flood routing, flood mitigation, flood forecasting, drainage system, infrastructure, maintenance
of the assets, zoning by direct observation and some interviews with officials of reservoir. The problem that occurred is always every year and mostly in the same place. Also the information that we get from the website is non-interactive.

Problem and solution:
1. Rainwater that fell and the overflow of rainwater from the higher regions provinces can not be managed properly. For instance, it rained only 5 hours it could cause flooding operations. It needs urgently to designing flood protection measures, Hydrology of the catchment area, it mean shows to build up a design flood based on the knowledge of hydrology of the catchment area.
2. Storage reservoirs currently not functioning optimally and manually operated. Thereafter, this required to plan re-engineering structures, its schedule of operations, so that the flood cannot cause serious damage downstream.
3. Today flooding could come suddenly without early notification to residents and may causing loss of material and human life. Further as the floodwave passes through a stream it is necessary to know how the stage varies with respect to time and distance for the design of river engineering works as well as for issuance of flood warning by the civil authorities.

4. Current water pump system is not well integrated, electricity is not equipped with backup power, so if the power fails then the pump is can not use. It is need an installing pumping facilities which comes under drainage engineering and with integration system.

Conclusion:
With this current state, it is no wonder if Jakarta famous with the flood in every year. This must be repaired and done some innovations, by cooperating with universities to conduct research and continuous improvement for a greater goal. Ensure operation and maintenance personnel are part of project planning and development process including developing criteria for the initial commissioning of the project and wherever possible, choose an easily maintained system. Knowledge is considered today to be one of the main assets of a company. Together company and university can try to develop new approaches and find answers to those challenges.
Perceived climate variability and water scarcity: stress experiences and survivalist responses in water resources management in Cameroon

EM. Fomba (1); TM. Noukeu (2)
(1) University of Dschang,_pps-psychology, Dschang, Cameroon; (2) University of Dschang, Former student, pps-psychology, Dschang, Cameroon

Despite the interplay of many factors, climate variability has been recognised for degrading fresh water resources, destabilising human behaviours and activities; drawing in behavioural intervention as an indispensable dimension of integrated water resources management. Positioning water at the centre of human life and activities the paper regrets that human behaviour appears the least understood dimension of global change, climate variability and accompanying risks such as water related stress, thereby undermining human factors in management options and survivalist behaviours of local people.

It asserts that emerging strategies in natural resources management drawn from climate variability have embraced people-centre models as core strategic values in sustainable water resources management with improved quality of human factors. An understanding the psychology of people as facilitators and inhibitors of effective outcomes in physical water systems. In context, increased recognition and focus on the human factor in water behaviour, water crisis, stress experiences and response measures are evidenced by the critical role of human behaviours. While crisis relating to water resources management has been generally approached from physical science perspectives, the paper upholds that water management is a psychological problem, and human behaviour can provide significant insights into the antecedents and consequences of water crisis. Also, it is so critical in understanding the role of human behaviours as a prerequisite to linking the physical sciences to the broader social context while promoting water conservation behaviours capable of stress aversion. The present study investigated perceived climate variability, water scarcity and adaptive strategies of local people. A sample of 254 participants (52.4% males, average age 28.39, (SD, 9.08), were drawn from Bangangte, Cameroon. A self-report questionnaire with significant internal consistency was used to collect data, and descriptive and inferential statistics used for analysis. Results revealed significant relationships among study variables with a high correlation between climate variability and water scarcity and stress experiences, suggesting the relevance of a behavioral framework in the analysis of climate variability and sustainable use and management of water resources. Also, a high correlation between climate variability and water scarcity was significant, while perceived water scarcity and stress experiences were insignificant. Regression analysis confirmed perceived climate variability, water shortage and stress as significant predictors of adaptive responses and mitigation behaviors. Apart from perception of water crisis, t-test analysis showed no significant gender differences for stress level, adaptive and mitigating behaviors. From analysis, the human-centre model constitutes a pathway toward sustainable water management capable of promoting adaptive competences, strategies and actions. While the study has implications for policy, research and practice, it strongly advocates the integration of behavioral science mechanisms in addressing climate variability and natural resources management dominated by physical sciences. in an anxiety-provoking era of global change.

Motivation to engage in sustainable behaviour

L. Steg (1)
(1) University of Groningen, Groningen, Netherlands

Contribution to session no. 3316 (convened by Dr. Sabine Pahl)

Sustainable development implies a future in which both environmental quality and human well-being are secured. Yet, sustainable behaviour is often believed to be less attractive (e.g., more expensive, time consuming, effortful), which may inhibit sustainable choices as thinking threats individual well-being. Notably, hedonic values that make people focused on what makes them feel good, and egoistic values that make them focus on how to increase their resources often inhibit sustainable behaviour, particularly if such behaviour is costly or effortful. Both reflect self-enhancement values. In contrast, altruistic values that make people focused on ways to benefit others, and biospheric values that make people focus on benefitting nature and the environment generally promote sustainable behaviour; both reflect self-transcendence values. Next, I indicate via which processes values affect sustainable behaviour. More specifically, I will illustrate that values affect which behaviour consequences people find important, and how they evaluate behavioural consequences given the implications of the relevant behaviour for their important values. Moreover, values affect the activation of personal norms, that is, feelings of moral obligation to engage in sustainable behaviour, that in turn affect the likelihood of such behaviour. Also, engaging in sustainable actions make people good, and people may anticipate such positive feelings elicited by doing the right thing, which may promote sustainable actions. Finally, I will discuss factors that may activate or deactivate values, the relevance of the relevant values steer sustainable choices in a given situation. Values can be activated by value-related cues, costs of sustainable behaviour, and situational cues that reflect that other people respected or disrespected norms, and acted upon their self-enhancement rather than their self-transcendence values.

Behaviour change or lifestyle change? Evidence and prospects for behavioural ‘spillover’

L. Whitmarsh (1)
(1) Cardiff University, School of Psychology, Cardiff, United Kingdom

Contribution to session no. 3316 (convened by Dr Sabine Pahl)
There is increasing acknowledgement that profound changes to individual behaviour are required in order to tackle climate change, and yet policies to achieve these changes have so far met with limited success. Most people are willing to make only very small changes to their lifestyle – so new ways of encouraging green behaviour which can match the scale of the climate change challenge are needed. The UK government and several psychologists have suggested behavioural ‘spillover’ might be a way to achieve this. Spillover is the notion that taking up one green behaviour (e.g., recycling) can lead on to other green behaviours (e.g., taking your own bags shopping). Ultimately, this might hold the key to moving beyond piecemeal behaviour change to achieving more ambitious, holistic lifestyle change. This talk will present initial work to explore when spillover does, does not, and could, occur using correlational and experimental data. First, factor analysis and regression analysis of survey data (both cross-sectional and longitudinal) will be presented, exposing clusters of pro-environmental behaviours that co-occur, potentially indicating spillover between actions similar in difficulty and/or location. This study exposes how consistent individuals are in their behaviour and which factors (e.g., identity) might underlie spillover; it also provides some insight into which behaviours might act as ‘catalyst’behaviours to trigger spillover to similar actions. Next two studies are presented which focus on the potential for specific behaviours – installing insulation and carrier bag reuse – to trigger behavioural spillover. Analysis of survey data (N=736) of Welsh homeowners’ adoption of energy efficiency measures shows that those who adopt home insulation are significantly more likely to undertake other energy saving measures (e.g., turning down thermostats) in the home. This relationship holds when controlling for environmental concerns. The potential for networking spillover to may be occurring in this context. A field experiment of the Welsh carrier bag change, will be presented that finds carrier bag reuse does not lead to behaviour ‘spillover’ to similar waste-related pro-environmental behaviours. These divergent findings highlight the importance of contextual factors in facilitating pro-environmental behaviour and behavioural spillover, and a need to understand the mechanism underlying spillover. Ongoing lab experiments to induce behavioural spillover and thereby expose this underlying mechanism will briefly be discussed, along with implications for policy and practice.

O-3316-06

Global middle classes and their carbon footprints

F. Reusswig (1); A. Garg (2)
(1) Potsdam Institute for Climate Impact Research (PIK), Transdisciplinary Concepts and Methods, Potsdam, Brandenburg, Germany; (2) Indian Institute of Management Ahmedabad, Public systems group, Ahmedabad, India

While many climate change scholars from the social sciences (including economics) have paid attention to the GHG emissions contribution of different countries (including average per capita incomes and per capita emissions), we do know much less on emissions by individuals worldwide (regardless of country). But the development of the former (e.g., measured in average GDP) and the latter are linked: the richer countries get on average, the higher the income inequality, and the larger the share of the population that moves from the national poor to the national middle classes. Currently, this is particularly the case in rapidly developing countries such as India and China.

We will present estimates of individual income by class, and of the respective carbon footprints by class. Our main reference points are comparing the US, and India. On basis with respect to income distribution worldwide will be the work of Xavier Sala-i–Martin and Thomas Piketty on the one hand, and national statistics on the other. The assumption is that individual footprints will be based on nation-specific carbon footprint assessments and calculators.

Our results will show that while individuals from the developing world are still responsible for the vast majority of GHG emissions, upper and upper middle classes in some rapidly developing countries have now entered the global ‘responsibility space’, i.e. emit above per capita world average. We will discuss the implications of these findings both for national and for international climate policies.
Addressing the behavioural gap in energy/economy models: Outcomes of the BE4 Workshop and outlook for the state-of-the-art

H. Daly (1)
(1) UCL Energy Institute, London, United Kingdom

Energy system optimisation models (ESOMs) simulate long-term least-cost energy system trajectories with high technology resolution, and are frequently used to better understand the trade-offs of sustainable technology transition possibilities for the future energy system. ESOMs are commonly used to portray the whole energy system, depicting energy technologies at every stage in the fuel supply chain, from fuel extraction through to final end-use. These models are heavily used in national decision-making and have been influential in the design of low-carbon policies, and so bare a burden of responsibility in realistically depicting energy system dynamics.

Whole-system energy modelling approaches have been successful at capturing the technological complexity and economic feedbacks of the energy system, and are used as integration tools for exploring trade-offs in climate mitigation, fuel poverty and energy security priorities. However, building sustainable energy systems requires a focus on behaviour, along with technological development. Behaviour plays a major role in the uptake and use of energy technologies, in driving energy service demand, and its treatment cannot be excluded from the analysis of long-term energy transitions. Researchers are increasingly looking to treat the decision-making and have been influential in the design of low-carbon policies, and so bare a burden of responsibility in realistically depicting energy system dynamics.

This contribution will address the growing priority of better representing behaviour in energy modelling approaches by bringing together researchers with expertise in representing energy efficiency and behaviour in complex energy systems. The BE4 Workshop, which will be held on April 20th and 21st, 2015, at University College London*. BE4 will bring together for the first time energy system researchers with expertise in representing energy efficiency and behaviour in complex energy systems. The aim of the workshop is to develop a better understanding of the state-of-the-art in this emerging field, to identify knowledge gaps, and to create a community to gain exposure to research in other fields which has successfully integrated behaviour into energy system modelling approaches. The workshop will have high-profile speakers and sessions describing state-of-the-art research. The workshop is funded by IEA-ETP, a consortium of teams led by the IEA that actively cooperate to establish, maintain, and expand E4 model capacity, and WholeSEM, a consortium which plays an underpinning role for the UK’s national strategic energy modelling activity.

BE4, and this presentation, will address the following themes:

- Heterogeneity in the population;
- Hidden costs in decision-making;
- Non-cost-optimal decision frameworks;
- Discrete choice analysis in whole-system approaches;
- Agent based modelling approaches;
- Integration of social sciences with E4 modelling.

Towards solutions that transcend technology and markets: The role of choices and behaviour change

S. Pahl (1) ; A. Pegels (2) ; Y. Mulguteta (3)
(1) Plymouth University, Psychology, Plymouth, Devon, United Kingdom; (2) German Development Institute / Deutsches Institut für Entwicklungspolitik (DIE), Sustainable Economic and Social Development Department, Bonn, Germany; (3) University College London, Science, Technology, Engineering & Public Policy, London, United Kingdom

Human choices and behaviour play a crucial role in climate change. "Human beings are the cause of the transformation, and only action by human beings can save arising from this workshop, this conference contribution will review the challenges that face integrated energy and mitigation planning tools across temporal and spacial scales.

P-3316-03
Energy efficiency and behavioural change in Uganda’s small-scale industry
B. Never (1)
(1) German Development Institute / Deutsches Institut für Entwicklungspolitik (DIE), Bonn, Germany

Energy efficiency counts as a low-hanging fruit in the combat against climate change and the transformation towards a low-carbon future. Investments in energy efficient technology and energy management practices offer a lot of benefits to industries in developing countries, but these are often not reaped. This so called energy efficiency gap exists in Uganda as much as elsewhere. Small-scale enterprises particularly struggle with the closure of this gap due to a combination of financial, organizational and informational barriers, as different studies have shown. This contribution will show that there is also a behavioural story to be told. Removing behavioural barriers and using psychological insights to design tailored policy packages belongs in the climate mitigation toolbox as much as in the development toolbox.

This contribution takes an innovative interdisciplinary approach combining development economics, behavioural sciences and environmental psychology to analyse the behavioural barriers and barriers to energy management in Ugandan micro- and small enterprises. The paper is an empirical contribution that draws on 45 on semi-structured interviews and focus group discussions conducted in Eastern Uganda in April 2014.

The main findings are that behavioural barriers impeding energy efficiency are not due to technical constraints or the lack of appropriate technology, but because these enterprises, the cognitive focus on and preference for short-term benefits, habits and a status quo bias as well as a lack of trust impede the uptake of energy efficient technologies and energy saving business practices by the MSEs. It has become clear that those entrepreneurs who have started to manage the electricity consumption of their business were supported by direct, first-hand experience with energy efficient technology and practices, a qualitative approach to this study does not allow for larger generalizations, the findings indicate a positive effect of changing energy management behaviour on business development and performance, if context conditions such as sufficient business skills and market access are provided for. Strong behavioural drivers are likely to be conducive to energy management and enterprise performance, while the strength of strong behavioural barriers negatively impacts performance. Thus, supporting behavioural change in small-scale industries can have positive effects for mitigating climate change, economic growth and development.

P-3316-04


P-3316-02

Non-cost-optimal decision frameworks;
the world from its worst impacts” (US Secretary of State John Kerry, Sept 27, 2013). This session explores how research on choices and behaviour can facilitate interdisciplinary, integrative responses to climate change. Talks will draw on social science theories and present novel data that connect individual pathways of social change with the public, interventions that change behaviour, and policy responses. The explicit aim of our session is to go beyond technological and market solutions and focus on behavioural change. A central aim of the conference programme is that the focus of our session will be on energy efficiency and savings, offering solutions for the double challenge of climate change mitigation and development. The IEA estimates that 18 per cent of the global population lack access to electricity. At the same time, the energy sector accounted for over 70 per cent of global greenhouse gas emissions in 2011. Greenhouse gas emissions overall have grown 60 per cent since 2000 and 10 per cent in the previous three decades. Addressing carbon emissions and reforming the energy system will be vital for limiting global warming but poses different challenges for industrialised and developing countries. While technological innovation and carbon prize mechanisms will play a major role in transitioning towards a low emissions economy, it is questionable whether this technological and market frame is sufficient to realise this transition. Human decisions, behaviours and broader lifestyles are key to achieving a meaningful, acceptable and inclusive transition. Only taking a ‘people-focused’ perspective will provide a buffer against market failures such as risk, information, hidden costs, access to capital, and split incentives. Contributions will discuss the key factors that contribute to behaviour change by presenting the results of empirical studies (e.g., an intervention) and/or specific behaviour that can "spill" over to other domains. We will also consider whether a behaviour change approach in the context of the targets of the Paris climate agreements and ‘locked-in’ lifestyles. This session will bring together social scientists including economists and psychologists, scientists, engineers and policy makers to explore the potential of behavioural, choice and lifestyle solutions to addressing climate change. The session finishes with our team working with three specialists in global environmental change. Michael Depledge (Professor of Environment and Human Health, University of Exeter, UK) will lead this session with his experience as advisor to the United Nations and the European Commission. Together we will sketch a map illustrating how social data and new data might be used to enhance our responses to climate change and foster sustainable lifestyles. Six speakers are planned with 10 minutes for each presentation, plus a poster session and a panel discussion at the end.

P-3316-05

Behaviour change for household energy use: The example of visualising heat loss through thermal imaging

S. Pahl (1) ; C. Boomsma, (1) ; J. Goodhew, (1)
(1) Plymouth University, Psychology, Plymouth, Devon, United Kingdom

Energy use plays an important role in climate change and is linked to issues of energy security and fuel poverty. Householders in particular play a key role in energy conservation through the decisions they make about purchase, use and maintenance of their homes. This session will consider how visualisation and focused feedback can improve the level of tailoring that is needed to change household intentions and behaviour. Thermal images were shared with more people (social multiplication) and associated with stronger intentions and actions, when they were tailored and personal to people’s own home, compared to images that showed a typical home. But seeing any thermal image (whether personal or typical) led to better memory and thinker behaviour intentions and actions. An exclusive focus of this session will be on energy efficiency and savings, offering solutions for the double challenge of climate change mitigation and development. The IEA measures that 18 per cent of the global population lack access to electricity. At the same time, the energy sector accounted for over 70 per cent of global greenhouse gas emissions in 2011. Greenhouse gas emissions overall have grown 60 per cent since 2000 and 10 per cent in the previous three decades. Addressing carbon emissions and reforming the energy system will be vital for limiting global warming but poses different challenges for industrialised and developing countries. While technological innovation and carbon prize mechanisms will play a major role in transitioning towards a low emissions economy, it is questionable whether this technological and market frame is sufficient to realise this transition. Human decisions, behaviours and broader lifestyles are key to achieving a meaningful, acceptable and inclusive transition. Only taking a ‘people-focused’ perspective will provide a buffer against market failures such as risk, information, hidden costs, access to capital, and split incentives. Contributions will discuss the key factors that contribute to behaviour change by presenting the results of empirical studies (e.g., an intervention) and/or specific behaviour that can "spill" over to other domains. We will also consider whether a behaviour change approach in the context of the targets of the Paris climate agreements and ‘locked-in’ lifestyles. This session will bring together social scientists including economists and psychologists, scientists, engineers and policy makers to explore the potential of behavioural, choice and lifestyle solutions to addressing climate change. The session finishes with our team working with three specialists in global environmental change. Michael Depledge (Professor of Environment and Human Health, University of Exeter, UK) will lead this session with his experience as advisor to the United Nations and the European Commission. Together we will sketch a map illustrating how social data and new data might be used to enhance our responses to climate change and foster sustainable lifestyles. Six speakers are planned with 10 minutes for each presentation, plus a poster session and a panel discussion at the end.

P-3316-06

The Environment and Data: Using Quantitative Data and Methodology to Encourage Environmental Civic Responsibility

M. Perkins (1)
(1) Concordia University, Sociology & Anthropology, Montreal, QC, Canada

This paper analyzes the innovative potential of working with the Environments and Environment Survey, run biennially by Statistics Canada, while proposing new instruments of measurement using this nation-wide data. Previous research has focused on small geographic areas and not in nation-wide contexts. In addition to this, the focus of research around eco-citizenship has been mainly theoretical and/or used qualitative methods. While this work has been critical to scholarly understanding of the situation and conceptualization regarding eco-citizenship, it has mainly dismissed the vast amount of aggregate data available to researchers. This paper considers emergent innovations regarding the ways in which we might incorporate this data, as well as new quantitative methods and instruments, into environmental sociology. The data available provides a unique opportunity to create and implement an index for the analysis of our current situation regarding Canadian participation in behaviours indicative of eco-citizenship. This research will subsequently allow me to develop further instruments and tools to build upon scholarly understanding of eco-citizenship at nation-wide and global levels.

This paper will also create a framework that could be developed for use in other countries, generating new information on the status of eco-citizenship. The author looks into the civic responsibility and governance issues surrounding the use of a highly statistical, government collected data and exercising what may seem to be a top-down authoritative approach compared to usual environmental approaches emphasizing horizontal authority. While initially problematic, the author believes that it is not the use of data that defines this action but how that data is used. Therefore, what is being exercised is not responsibilization through statistics, but an engagement in environmental civic responsibility to bring citizens and communities into the knowledge and process.

P-3316-07

Mobility choices and climate change: which incentives are effective?

C. Raux (1)
(1) University of Lyon, Laboratoire d’Economie des Transports, Lyon, France

Transport generated 22 per cent of anthropogenic CO2 emissions in the world in 2011 with three-quarters due to road transport and a continuous increase at least since 1990. There is a majority consensus among climate scientists and economists on a need for a sharp reduction of anthropogenic greenhouse gas emissions in the next few decades. Regarding transport it is recognized that improvements undertaken in vehicle energy efficiency will not be sufficient in the coming decades and that behavioral changes are also needed, such as shifting from individual
to public transportation or lower-emission modes per passenger-km or even reducing kilometers travelled.

Regarding behavioral changes, carbon taxes and vehicle taxes are advocated by economists as the most cost-effective instruments. Variants of economic incentives like personal carbon trading have also been proposed. Their roots can be found in the economic literature initially as a combination of economic incentive and quantity control, mostly marketable or Tradable Permits. Due to the specific nature of tradable permits applied to personal consumption of fuel, potential supplementary outcomes when compared to a carbon tax are expected on psychological grounds rather than economic ones. One effect might come from making carbon visible at the end-user level, with a carbon account delivering frequent feedback on travel behavior (i.e. "carbon budgeting"). Another effect could come from the social norm associated with a personal allowance fixed within the frame of a public policy.

By the means of a series of discrete choice experiments in a transport choice context we estimate and compare the impacts of economic and psychological incentives in motivating environmentally responsible mobility behavior.

In a first experiment the potential effectiveness of personal carbon trading (PCT) in changing car travel behavior was compared to the conventional carbon tax (CT) by means of a stated preferences survey conducted among French drivers (N=300). We show evidence that PCT could effectively change travel behavior and hence reduce transport emissions from personal travel. There is however a definite reluctance to reduce car travel. We were unable to demonstrate any significant difference between the effectiveness of PCT and the CT with regard to changing travel behavior. However, in the experiment, the PCT scheme provided consistent results while this was not the case for the CT scheme. This was an indication of a potential "social norm" effect conveyed by a personal emissions allowance.

In the second series of experiments we explored the trade-off between travel price and travel time on 900 participants, while introducing in a controlled setting various effects such as marketable or Tradable Permits, CO2 emissions, injunctive and descriptive social norms, and fiscal incentives such as a carbon tax, a bonus-malus and a carbon trading scheme. By "framing" we mean the ways of presenting a choice based initially on objective economic properties (here the trade-off between travel price and travel time) that do change psychological aspects (information on CO2 emissions, injunctive and descriptive social norms) and sometimes economic aspects by imposing fiscal incentives (tax, quotas and bonus–malus).

Statistical evidence shows that providing CO2 information on emissions is highly effective and the injunctive norm reinforces this effect in the case of air and train. A quota scheme reinforces the injunctive norm effect in the case of these two modes. More strikingly, the amount of the financial sanction or reward has no effect on the probability of using the various travel modes, unlike the presence of the fiscal framing itself.

There are some policy implications of such results. First they confirm and reinforce the case for using psychologically positive framing effects in promoting effective pro-environmental behavior in transport choices. Providing basic CO2 emissions information on each travel alternative is likely to yield actual behavior changes. Normative messages through benchmarking (bonus-malus) or carbon budgeting (quotas) may reinforce the incentive especially for larger emitting modes. The amount of the financial (dis)incentive in itself might not matter regarding the effect on behavior change.

P-3316-08

Co-design of a place-based educational videogame on climate change: Future Delta 2.0
S. Sheppard (1)
(1) CALP, Vancouver, Canada.

Contribution to session no. 3316 (convened by Dr. Sabine Pahl)

This presentation describes a co-creation and evaluation process for a community-based interactive educational videogame on local climate change solutions, developed for a case study in the coastal municipality of Delta, British Columbia, Canada.

This project uses video gaming to enable interactive exploration of local climate change threats and solutions in a real place. Delta faces challenges such as sea level rise, agricultural decline, heat–waves, and growth fuelled in part by environmental factors. The project builds on the Collaborative for Advanced Landscape Planning (CALP) team’s earlier research in Delta, collaborating with various levels of government and multiple stakeholders, and demonstrating the power of science–based visualizations in raising awareness and motivation on climate change. The aim is to make climate change science and solutions more salient and creative, in a way that conventional educational methods often fail to achieve. The videogame will allow players to visualize what their own future might look like, and explore a variety of tough choices that citizens of Delta may need to make.

Taking advantage of earlier Future Delta videogame prototypes, the co-design phase focuses on local high-schools, in partnership with Delta School district. The game design borrows from commercial videogame techniques in order to provide a compelling virtual environment for: i) place-based learning in geography and science classes, and ii) student engagement on local climate change realities, collective action and policies for adaptation and mitigation. Teachers and students will design the game collaboratively with researchers, through an iterative process of focus groups and gameplay sessions. Participants provide input on integration of class/curriculum learning objectives, the fun of game play, and storyline ideas reflecting local themes and identity. The presentation will report on the co-design process and preliminary evaluation results on input from students, teachers, families and friends, shedding new light on responses to climate change impacts and choices in a videogame environment.

3317 - Mainstreaming low carbon consumption: challenges and opportunities

Oral Presentations

K-3317-01

Low carbon living and energy demand as a shared social problem: from the little to the big
G. Walker

Bringing low carbon into being evidently means far more than innovating only in technological terms. Co-evolving social change is also necessary, on a scale that extends beyond those people that are already committed, beyond individual attitudes and behaviours, to the truly collective, societal and structural. In this paper I consider the implications in terms of both how we understand the nature of much of the energy consumption that makes up the carbon burden of contemporary living, the challenges involved in achieving ‘preferred’ forms of low carbon social change (in both energy and social justice terms) and ways of political articulating of what is at stake in governance terms. I will draw on recent research projects focused on the relation between social practice (shared forms of everyday living at home, at work and in moving around) and energy demand, including work on the spread of air conditioning, the mainstreaming of zero carbon homes, energy use in the living spaces of older people and flexibility in the temporal patterns and rhythms of daily energy demand.
Daily innovations, social practices and sustainable consumption – Some insights from real life

S. Douzou (1)
(1) EDF, Research and development, Clamart, France

Daily innovations aiming at reducing CO2 emissions and energy consumption constitute the cornerstone of most scenarios and visions of the future underpinning climate change mitigation related policies and options for the residential sector. Not without reasons: the ambitious targets are currently may necessarily be achieved partly thanks to the integration of a sophisticated set of socio–technical eventual innovations. Under certain conditions however, Provided that such projections of the future will be actually performed, incorporated and eventually mainstreamed in a given real social context. This communication will stress on the ‘reception’ and appropriation processes of such patterns in order to understand the social acceptance such innovations related to ‘real’ conditions of innovations insertion/cool-system. Based on selected case and field studies we will show that these are indeed deeply anchored in a particular historical, social and evolving context of a given society and, as such, that Home Energy related innovations are hybrid and co-shaped devices resulting from an intertwined process of innovation and social incorporation. By questioning this process is dynamic, multi-scale and multi-players. When questioning the many current policies and measures are formulated, as well as their main underlying assumptions illustrated by such notions as ‘public acceptance’ or ‘social acceptance’ we will plead for a move towards broader and more suitable concepts. We will use some key-notions mainly derived from practice–based theory as applied to energy field, in order to develop a two-fold argument aiming at socially contextualise the field studies. We will finally open up the discussion about how we could (should?) think and found differently Energy related policies in order to make them more efficient and impactful.

International Consultation on Consumption Patterns for Sustainable Development

CRSM. Souza (1) ; M. Poppe, (2) ; ACF. Galvão, (3)
(1) Centre for Strategic Studies and Management in Science, Technology and Innovation (CGEE), Sustainable development, Brasilia – DF, Brazil; (2) Centre for Strategic Studies and Management in Science, Technology and Innovation (CGEE), Sustainable development, Brasilia – DF, Brazil; (3) Centre for Strategic Studies and Management in Science, Technology and Innovation (CGEE), Brasilia – DF, Brazil

The current debate on the post–2015 development agenda and the sustainable development goals leads to a discussion of the points of departure of pathways for sustainable development, which must take into consideration how citizens, businesses and governments consume and how such patterns of consumption can be changed. With this in mind, the Brazilian Center for Strategic Studies and Management (CGEE) in cooperation with the Akatu Institute for Conscious Consumption, the Brazilian Business Council for Sustainable Development (CEBDS), the Institute for Sustainable Development and International Relations (IDDRi), the Institute of Research and Development (IRD), the Swedish Agency for Growth Analysis, the United Nations Economic Commission for Latin America and the Caribbean (ECLAC) and the World Centre for Sustainable Development (Rio + Centre) organized the present international web–based consultation on consumption patterns for sustainable development. The consultation was addressed to a select group of people from academia, government, civil society and business sectors.

Agenda 21, adopted in 1992 at the United Nations Conference on Environment and Development (Rio 92) stated that “the major cause of the continued deterioration of the global environment is the unsustainable pattern of consumption and production” and recommended “a multipronged strategy focused on demand, meeting the basic needs of the poor and reducing wastage and the use of finite resources in the production process”. In 2012, world leaders once again met in Rio de Janeiro to attend the United Nations Conference on Sustainable Development (Rio+20). The conference outcome document, «The Future We Want», reaffirmed the commitment to fully implement Agenda 21 and called for the construction of Sustainable Development Goals (SDGs) to go beyond the Millennium Development Goals (MDGs) and frame the path to sustainable development.

The survey intends to contribute to the ongoing international negotiations for the definition of the SDGs at the United Nations. This discussion represents an important stepping–stone towards the creation of a global model for sustainable development. It should engage and establish commitments for both developed and developing countries, as well as balance the social, economic, and environmental dimensions of sustainable development, including the challenges presented by a changing climate. Therefore, the objective of the consultation is to map out society’s perceptions and recommend patterns in the context of sustainable development and climate change to enable a comparison of the different views, as well as to identify commonalities, in order to help bridge knowledge, gaps that may arise in the negotiation of the SDGs and of a new international treaty on climate change in 2015.

Mainstreaming low-carbon consumption: Opportunities, challenges and promising policy approaches

B. Girod (1)
(1) Group for Technology and Sustainability, ETH Zurich, Zurich, Switzerland

Consumption-oriented climate mitigation approaches aim for a reduction in emissions caused by regional consumption (including imported goods), while production-oriented approaches account for all emissions attributable to regional production (including exported goods). Although currently the production–oriented approach is predominantly applied in climate policy, the consumption–oriented approach offers several advantages. These include lower carbon leakage and reduced economic competitiveness concerns over the relocation of intensive production to regions without climate mitigation requirements. However, addressing emissions via consumption also comes with several new challenges. Policies aiming at radical changes in consumption patterns or reduction of consumption levels suffer from low public acceptance. The consumption–oriented policies with the highest acceptance are those that favour changes in consumption choices (product choices, consumption levels (rebound effects)). These policies still face three major challenges: First, they have to account for increasing consumption levels (rebounds). Second, emissions embodied in the products (life–cycle emissions) need to be considered. Finally, the choice of policy instruments is limited by the path dependence of policymaking as well as by feasibility and public acceptance of the different instruments.

To address these challenges, a policy framework is developed that indicates how the carbon intensity of consumption could be reduced in line with the international climate target. The framework shows how the integration of climate mitigation options and consumption intensity targets for products. Comparing these targets with existing low–carbon products indicates that products in line with the required emissions reductions for 2050 are available for the main consumption categories (food, shelter, mobility, goods and services). Hence, to achieve the carbon intensity targets on the product level, the timely diffusion of existing low–carbon options is key. The framework therefore also describes how such carbon intensity targets can be achieved by describing the stylized development of consumption–oriented policies that were successfully implemented in the past. These include policies for mainstreaming low–carbon cars, energy–efficient buildings and appliances as well as sustainable timber products in the European Union. Learning from these policy experiences suggests that successful policy development is a stepwise process: starting with very stringent standards. The stepwise increase in stringency typically starts with voluntary and information measures. Public procurement and financial incentives contribute to further diffusion of the low–carbon products. This provides the basis for introducing binding standards, which are then regularly tightened. Once established, standards can
also be extended to include additional products and may become more comprehensive (e.g. also include other life-cycle emissions).

The framework helps guide future policymaking and allows the identification of the type of scientific research and policy support required to extend and improve consumption-oriented climate mitigation policy. While in the area of meat consumption and air travel the development of low-carbon innovations is necessary to provide low-carbon consumption options, most other consumption areas call for the mainstreaming of existing low-carbon options. Thus it is essential to achieve a better understanding of how to accelerate the development towards low-carbon standards for all consumption categories. International climate policy can foster this development by supporting the harmonization of carbon footprint norms for products. This will help to guide low carbon consumption, enhance conformity with international trade and facilitate the extension to embodied emissions of existing consumption-oriented climate policy.

O-3317-04
Carbon emission mitigation by Consumption-based Accounting and Policy

A. Tukker (1); D. Crawford-Brown (2); E. Van Der Voet (3); R. Wood (4); A. Anger (5)
(1) TNO, Strategy and policy, Delft, Netherlands; (2) University of Cambridge, Centre for Climate change mitigation research, Cambridge, United Kingdom; (3) Leiden University, Cml, Leiden, Netherlands; (4) NTNU, Trondheim, Norway; (5) CE, Cambridge, United Kingdom

Carbon emission mitigation by Consumption-based Accounting and Policy (Carbon–CAP)

Current climate policies are mainly shaped via territorial emission reduction approaches. Yet, growing consumption is a main driver behind rising greenhouse gas (GHG) emissions. Further, our economy is increasing a single, global economy: international trade has risen threefold since 1990 implying pollution embodied in trade is now responsible for a significant part of total GHG emissions. Complementing territorial mitigation approaches with policies from a consumption oriented perspective hence can have added value. They can explicitly address consumption as a driver for rising GHG emissions, next to the problem of carbon leakage. However, there are significant questions about consumption based carbon accounting (CBCA) systems (Gap 1: CBCA reliability) and demand side policies (effectiveness (Gap 2) and societal impacts (Gap 3)). Stakeholders hence can easily question their added value (Gap 4).

The Carbon–CAP project aims to (1) stimulate innovative European and international demand side climate policies and services due to more reliable and improved shared insights about consumption based GHG emissions, and (2) to realize a more effective policy mix for achieving the objectives of the EU Climate and Energy package and the Roadmap for moving to a competitive low carbon economy in 2050, by quantitatively analyzing the added value of consumption-oriented climate mitigating policies.

Carbon–CAP will deliver insights in reliability and uncertainty in Consumption based carbon accounting (CBCA) and recommendations for an approach for implementation of a robust, reliably system for CBCA. A recommendation which demand side policy instruments have most added value in complementing existing territorial mitigation approaches, with their environmental and economic implications tested via three modelling perspectives.

This presentation will be part of our process of interactive learning between the project team and key players in the policy area. We will present our intermediate findings and will stimulate discussion and reactions in order to fine tune our approach and outcomes.

O-3317-05
Designing and experiencing social practices in LivingLab environments - A novel approach to transform routinized behaviour via materialized social innovations

C. Liedtke (1); C. Baedeker, (1); J. Buhl, (1)
(1) Wuppertal Institute for Climate, Environment and Energy, Sustainable production and consumption, Wuppertal, Germany

In recent years, theories of social practices have gained a lot of attention in the analysis of consumption. Social practices are the locus of the social, where action and structure are mediated. Social practices and associated forms of behaviour consist of several elements, interconnected to one another: forms of bodily activities, forms of mental activities, ‘things’, and their use, a background knowledge in the form of understanding, know-how, states of emotion and motivational knowledge. In a nutshell: The interaction of material, skill and meaning. Social practice theories are just ideal for analysing routine behaviour itself but rather engaging in many practices requires a certain level of consumption of goods or services. Styles of consumption are intertwined with social practices of certain activities but also with daily routines i.e. in households. Consumers combine a number of different practices related to nutrition, mobility or housing and form them into lifestyles. The materials element shows how practices are directly related to consumption. Direct reference for objects or infrastructures needed to engage in a given practice. Continuous engagement in a practice, rising numbers of consumption and functioning as consumption-oriented climate mitigation policy. While consumption as a driver for rising GHG emissions, next to the problem of carbon leakage. However, there are significant questions about consumption based carbon accounting (CBCA) systems (Gap 1: CBCA reliability) and demand side policies (effectiveness (Gap 2) and societal impacts (Gap 3)). Stakeholders hence can easily question their added value (Gap 4).

The Carbon–CAP project aims to (1) stimulate innovative European and international demand side climate policies and services due to more reliable and improved shared insights about consumption based GHG emissions, and (2) to realize a more effective policy mix for achieving the objectives of the EU Climate and Energy package and the Roadmap for moving to a competitive low carbon economy in 2050, by quantitatively analyzing the added value of consumption-oriented climate mitigating policies.

Carbon–CAP will deliver insights in reliability and uncertainty in Consumption based carbon accounting (CBCA) and recommendations for an approach for implementation of a robust, reliably system for CBCA. A recommendation which demand side policy instruments have most added value in complementing existing territorial mitigation approaches, with their environmental and economic implications tested via three modelling perspectives.

This presentation will be part of our process of interactive learning between the project team and key players in the policy area. We will present our intermediate findings and will stimulate discussion and reactions in order to fine tune our approach and outcomes.

O-3317-05
Designing and experiencing social practices in LivingLab environments - A novel approach to transform routinized behaviour via materialized social innovations

C. Liedtke (1); C. Baedeker, (1); J. Buhl, (1)
(1) Wuppertal Institute for Climate, Environment and Energy, Sustainable production and consumption, Wuppertal, Germany

In recent years, theories of social practices have gained a lot of attention in the analysis of consumption. Social practices are the locus of the social, where action and structure are mediated. Social practices and associated forms of behaviour consist of several elements, interconnected to one another: forms of bodily activities, forms of mental activities, ‘things’, and their use, a background knowledge in the form of understanding, know-how, states of emotion and motivational knowledge. In a nutshell: The interaction of material, skill and meaning. Social practice theories are just ideal for analysing routine behaviour itself but rather engaging in many practices requires a certain level of consumption of goods or services. Styles of consumption are intertwined with social practices of certain activities but also with daily routines i.e. in households. Consumers combine a number of different practices related to nutrition, mobility or housing and form them into lifestyles. The materials element shows how practices are directly related to consumption. Direct reference for objects or infrastructures needed to engage in a given practice. Continuous engagement in a practice, rising numbers of consumption and functioning as consumption-oriented climate mitigation policy. While consumption as a driver for rising GHG emissions, next to the problem of carbon leakage. However, there are significant questions about consumption based carbon accounting (CBCA) systems (Gap 1: CBCA reliability) and demand side policies (effectiveness (Gap 2) and societal impacts (Gap 3)). Stakeholders hence can easily question their added value (Gap 4).

The Carbon–CAP project aims to (1) stimulate innovative European and international demand side climate policies and services due to more reliable and improved shared insights about consumption based GHG emissions, and (2) to realize a more effective policy mix for achieving the objectives of the EU Climate and Energy package and the Roadmap for moving to a competitive low carbon economy in 2050, by quantitatively analyzing the added value of consumption-oriented climate mitigating policies.

Carbon–CAP will deliver insights in reliability and uncertainty in Consumption based carbon accounting (CBCA) and recommendations for an approach for implementation of a robust, reliably system for CBCA. A recommendation which demand side policy instruments have most added value in complementing existing territorial mitigation approaches, with their environmental and economic implications tested via three modelling perspectives.

This presentation will be part of our process of interactive learning between the project team and key players in the policy area. We will present our intermediate findings and will stimulate discussion and reactions in order to fine tune our approach and outcomes.
Green Investment and Business Performance: The African Experience

O.J. Professor Adelegan (1); J. Adelegan (2)

(1) Lead City University, Economics, Ibadan, Oyo State, Nigeria, Federal Republic of; (2) Global Network for Environmental Research, Department of Environment and Sustainable Development, Ibadan, Oyo State, Nigeria, Federal Republic of

Addressing a paucity of research about industrial adoption of environmentally benign technologies in Africa and, more generally, in tropical developing countries, we examined the Nigerian pulp and paper industry as a case study. Our random sample of twenty upper echelon executives representing five Nigerian firms challenge conventional expectations that energy intensive industries in developing markets operate amid highly pollution-intensive conditions, within weak or non-existent formal environmental regulatory frameworks, and with limited institutional capacity. Our findings suggest a strong positive relationship between cleaner technology use and corporate financial performance of African industrial firms. Our study also suggests the adoption of classical ‘win–win’ integrated preventive environmental strategy, efficient energy use, and green procurement, which improves industrial efficiency and profitability. Nigerian pulp and paper firms are shown to have moved beyond end-of-pipe technologies and cleaner technologies and adopted industrial ecology and “zero emission” principles with appropriate reuse of the remaining waste streams turning the production system into a sustainable industrial ecosystem.

Green Cities: Benefits of Urban Sustainability

EHM. Ahmed (1)

(1) Lead Author, WG III, IPCC, climate change and sustainable development, Cairo, Egypt

In the wake of the global financial crisis 2008–2010, the concept of a green economy was provided with fresh impetus following widespread discussions on a “Green New Deal, to enable a ‘Green Recovery’. Large investments were seen as necessary to support the recovery of the world economy. The financiers offered an opportunity to invest in green economy sectors.

Nowadays many developed countries adopted the Green Cities concept as a new tool to face the environmental impacts in general, and the climate change impacts in particular.

With mainstreaming climate change concerns attention the world to adopt a new strategy for urban cities, we heard raising voices that asking to take GHGs reduction in account during the implementation of a new urban cities.

Regarding to the environment point of view, we have to take care about the whole natural sources we have, not to forget sustainability while we’re looking for development.

Green building that the usage of a natural or green materials in its structure; saving and reduce of other resources as lighting, water consumption and waste management are the main concern to get Green Cities.

The increase of productivity of workers in green buildings could achieve labor–cost savings that maybe higher than energy cost savings; challenge in developing countries is doing away with subsidized, non–cost–reflective energy prices; the quality of life and health care are also equally significant.

City governments need to coordinate policies and decisions with other levels of government, but more importantly, they need to be more prudent with their MC and integrated planning capacities. In poorer cities, the building up of such capacities is important, as is their access to financial resources for investing in the various sectors of green cities. Here it may be more prudent to adopt a more pragmatic and minimalist approach, which primarily commits municipal sectors such as water, waste, energy and transport to a limited number of overarching strategic goals.

Breaking Bad: Why We Need to Target Implicit, Automatic Associations in the Fight against Climate Change

G. Beattie (1); L. Mcguire (2)

(1) Edge Hill University, Psychology, Lancashire, United Kingdom; (2) Edge Hill University, Psychology, Lancashire, United Kingdom

There is growing recognition of the role of consumer behaviour in the dramatic increases in global CO2 emissions and, consequently, more critical role of consumers as a major influence on climate change itself. Some leading international figures from the commercial world have proposed that we need nothing short of a “green revolution” in consumer behaviour in order to cope with the threat posed by climate change. The argument is that consumers opting for low carbon alternatives would drive demand for more environmentally friendly products, and impact on carbon emissions with significant environmental consequences. Furthermore, many leading figures have argued that the public are ready for this ‘green revolution’ as they report in numerous surveys that they are ready to change their behaviour to mitigate the effects of climate change. This has led to campaigns in a number of countries to reduce energy use, to promote greener transportation, to highlight lower carbon footprint alternative products etc. The carbon labelling of products to guide consumer choice has now been rolled out in a number of countries, at very significant financial cost. However, these everyday consumer habits seem strangely resistant to change and many governmental, commercial, and educational campaigns have not had the desired, or anticipated, effects on actual consumer behaviour and consumer choice. For example, using eye tracking technology we found little difference in gaze fixation on carbon labels on products compared to the other information that features on such products (see, for example, G. Beattie, 2012, How effective is carbon labelling? labelling for the consumer in the context of Climate Change, 2, 214–217). One reason for the overall pattern of disappointing results on behavioural change in this area might be that there has been too much focus on assessing and changing explicit, self-reported attitudes rather than on more implicit attitudes, formed on the basis of underlying associative connections. For example, for years, many people have learned to associate high carbon footprint lifestyles with societal success (partly, of course, attributable to advertising) and this association can affect actual behaviour regardless of more rational decision making about adaptation and climate change. These implicit attitudes can now be measured using the Implicit Association Test (or IAT) and outcome measures from the IAT seem to predict the attentional focus of consumers, amongst other things, in a way that self report measures do not. In this paper, we will outline new experimental data on this topic, which examines the relative importance of implicit and explicit attitudes in determining consumer choice, in which the environmental consequences of the various choices are made clear to shoppers through the inclusion of various environmental labels, including features like carbon footprint, organic and Fairtrade. The research also considers other critical variables like the influence of choice under time pressure, the social context of the behavioural choice, and relevant budgetary concerns. The research demonstrates that underlying implicit attitudes are a better predictor of actual consumer choice in supermarket shopping, especially under certain circumstances, like time pressure, where the behaviour
Yves Rocher’s experience: 50 years of commitments to the preservation of the environment

A. Blain (1)
(1) Groupe Rocher, sustainable development, Issy-les-Moulineaux, France

Yves Rocher is a one-of-a-kind Brand, created over 50 years ago, that has chosen to master every aspect of its operations: Botanist, Harvester, Manufacturer and retailer. This specificity enables the Brand to manage all the fields in its business and therefore to reduce its environmental impact at every stage of its products’ life cycle.

With half a century of experience in Botanical Beauty, Yves Rocher sources almost 250 plant ingredients with a view to developing a responsible and effective protection of natural resources and local communities, sharing of the benefits resulting from the use of plants. Yves Rocher created its Botanical Charity, illustrating its commitment to the preservation of Biodiversity. Since 2008, Yves Rocher has also actively participated in the Natural Resources Stewardship Circle (NRS), organization of manufacturers from the beauty industry working together for a sustainable management of biodiversity in supply chains.

Besides, new exclusive active principles are created and developed every year by the Yves Rocher R&D teams, using the most environmentally-friendly extraction technology. Formulation guidelines have been implemented, and Yves Rocher, as a forerunner in the cosmetics industry has banned since 1989 all animal testing for its products and ingredients.

Furthermore, Yves Rocher eco-designs 100% of its packagings, reducing non-renewable resource consumption, designing packagings that can be recycled at existing facilities and encouraging customers to sort their packagings waste. In order to accompany teams engaged in product development, Yves Rocher developed «eco-design packaging guidelines». This tool is updated annually and is shared by marketing, purchasing, development and R&D teams. It provides instructions to follow in terms of eco-design for Yves Rocher products.

Yves Rocher industrial facilities fight global warming by reducing their fossil energy consumption, promoting renewable energies (wood-burning heating in Brittany, saving about 1600t of CO2/year), reducing CO2 emissions (-10%g C02/product since 2010), improving water efficiency (-19% water consumed/t of bulk produced since 2010).

Since 2010, Yves Rocher has integrated biodiversity management to the company’s strategy. In Brittany, 100% of the Yves Rocher industrial sites are « havens of Biodiversity ». The Brand is also a genuine Biodiversity Ambassador, hosting more than 3000 participants/year at its认识 converted into programs at the Botanical Garden and its own Eco-Hotel spa.

Environment preservation is at the heart of the Yves Rocher strategy with the support of the Yves Rocher Foundation, in order to leave a positive footprint:

Yves Rocher aims at establishing a new relationship to nature, acting with responsibility towards natural resources and being a biodiversity ambassador to its employees and its 30 million customers throughout the world.

The Yves Rocher Foundation created in 1991 by Jacques Rocher is a pioneer in positive ecology, and strives to transform the way we interact with our Planet. The Foundation–Institut de France acts through 4 sustainable programs that promote plant biodiversity through concrete initiatives in more than 50 countries throughout the world.

Through its “Plant for the Planet” program, the Yves Rocher Foundation will achieve its target of 50 million trees planted by the year 2020, working in a number of related domains, which could have a significant effect in the area of climate change.

P-3317-04

Understanding the « spirit » and legitimation of Green Economy, from selective to stabilized discourses. (provisional title)

C. Serre (1)
(1) Université de Lausanne (UNIL), Institut de Géographie et Durabilité (IGD), Lausanne, Switzerland

In this paper I present an aspect of the work I am currently conducting on the performative character of the green economy (GE) and the discourses produced around this theme. I study the emergence and the impacts of the GE guidelines on environmental policies, e.g. the set of guidelines on sustainable development and UNCTAD, and technological initiatives in more than 50 countries throughout the world. This program is supported by the Yves Rocher Foundation since 1991.

The Yves Rocher Foundation created in 1991 by Jacques Rocher is a pioneer in positive ecology, and strives to transform the way we interact with our Planet. The Foundation–Institut de France acts through 4 sustainable programs that promote plant biodiversity through concrete initiatives in more than 50 countries throughout the world.

Through its “Plant for the Planet” program, the Yves Rocher Foundation will achieve its target of 50 million trees planted by the year 2020, working in a number of related domains, which could have a significant effect in the area of climate change.

P-3317-04

Understanding the « spirit » and legitimation of Green Economy, from selective to stabilized discourses. (provisional title)

C. Serre (1)
(1) Université de Lausanne (UNIL), Institut de Géographie et Durabilité (IGD), Lausanne, Switzerland

In this paper I present an aspect of the work I am currently conducting on the performative character of the green economy (GE) and the discourses produced around this theme. I study the emergence and the impacts of the GE guidelines on environmental policies, e.g. the set of guidelines on sustainable development and UNCTAD, and technological initiatives in more than 50 countries throughout the world. This program is supported by the Yves Rocher Foundation since 1991.

The Yves Rocher Foundation created in 1991 by Jacques Rocher is a pioneer in positive ecology, and strives to transform the way we interact with our Planet. The Foundation–Institut de France acts through 4 sustainable programs that promote plant biodiversity through concrete initiatives in more than 50 countries throughout the world.

Through its “Plant for the Planet” program, the Yves Rocher Foundation will achieve its target of 50 million trees planted by the year 2020, working in a number of related domains, which could have a significant effect in the area of climate change.

P-3317-04

Understanding the « spirit » and legitimation of Green Economy, from selective to stabilized discourses. (provisional title)

C. Serre (1)
(1) Université de Lausanne (UNIL), Institut de Géographie et Durabilité (IGD), Lausanne, Switzerland

In this paper I present an aspect of the work I am currently conducting on the performative character of the green economy (GE) and the discourses produced around this theme. I study the emergence and the impacts of the GE guidelines on environmental policies, e.g. the set of guidelines on sustainable development and UNCTAD, and technological initiatives in more than 50 countries throughout the world. This program is supported by the Yves Rocher Foundation since 1991.

The Yves Rocher Foundation created in 1991 by Jacques Rocher is a pioneer in positive ecology, and strives to transform the way we interact with our Planet. The Foundation–Institut de France acts through 4 sustainable programs that promote plant biodiversity through concrete initiatives in more than 50 countries throughout the world.

Through its “Plant for the Planet” program, the Yves Rocher Foundation will achieve its target of 50 million trees planted by the year 2020, working in a number of related domains, which could have a significant effect in the area of climate change.

P-3317-04

Understanding the « spirit » and legitimation of Green Economy, from selective to stabilized discourses. (provisional title)

C. Serre (1)
(1) Université de Lausanne (UNIL), Institut de Géographie et Durabilité (IGD), Lausanne, Switzerland

In this paper I present an aspect of the work I am currently conducting on the performative character of the green economy (GE) and the discourses produced around this theme. I study the emergence and the impacts of the GE guidelines on environmental policies, e.g. the set of guidelines on sustainable development and UNCTAD, and technological initiatives in more than 50 countries throughout the world. This program is supported by the Yves Rocher Foundation since 1991.

The Yves Rocher Foundation created in 1991 by Jacques Rocher is a pioneer in positive ecology, and strives to transform the way we interact with our Planet. The Foundation–Institut de France acts through 4 sustainable programs that promote plant biodiversity through concrete initiatives in more than 50 countries throughout the world.

Through its “Plant for the Planet” program, the Yves Rocher Foundation will achieve its target of 50 million trees planted by the year 2020, working in a number of related domains, which could have a significant effect in the area of climate change.

P-3317-04

Understanding the « spirit » and legitimation of Green Economy, from selective to stabilized discourses. (provisional title)

C. Serre (1)
(1) Université de Lausanne (UNIL), Institut de Géographie et Durabilité (IGD), Lausanne, Switzerland

In this paper I present an aspect of the work I am currently conducting on the performative character of the green economy (GE) and the discourses produced around this theme. I study the emergence and the impacts of the GE guidelines on environmental policies, e.g. the set of guidelines on sustainable development and UNCTAD, and technological initiatives in more than 50 countries throughout the world. This program is supported by the Yves Rocher Foundation since 1991.

The Yves Rocher Foundation created in 1991 by Jacques Rocher is a pioneer in positive ecology, and strives to transform the way we interact with our Planet. The Foundation–Institut de France acts through 4 sustainable programs that promote plant biodiversity through concrete initiatives in more than 50 countries throughout the world.

Through its “Plant for the Planet” program, the Yves Rocher Foundation will achieve its target of 50 million trees planted by the year 2020, working in a number of related domains, which could have a significant effect in the area of climate change.
research explores the performative character of GE within the wider research project I am currently conducting, which aims to analyse whereby GE could contribute to (i) a shifting–produced process in the hegemonic capitalist model or, in contrast (ii) keeping, sustaining and reinforcing the capitalist model via dynamic ideologies through a new register of justification and a new spirit in the terms of Boltanski and Chiapello (1999). In order to investigate the potential dynamic of change or continuity of the GE notion on environmental policies, the identification of the different storylines (Hajer, 2005: Dryzek, 2005) helps to map the discourses that encapsulates key ideas of GE. In my study, I assume that a particular and selected vision of the world is carried out through GE rhetoric and discourses, conveying imaginations of hope and functioning with speculative argumentative thinking. To illustrate that, I will first trace the discursive and socio–historical co-construction of the GE notion through its evolution in time and space. I will then present an analysis of selected institutional discourses attempting to make sense of the different ways and options proposed to envision a “happy marriage” (Goldstein, 2014) between rhetoric and economy: presented through “green” options and promoted via positive and appealing discourses, these propositions justly adjusting present actions to the GE promise, e.g. the increase of economic growth as “a path towards planetary salvation” (ibid). Considering how such a vision comes to be justified and formulated, gains prevalence over others and finally unfolds as coherent understandings of socioeconomic realities, prefigures in my view an attempt to construct a growing sense of belonging to a common future. Indeed, I assume that ontologies of the world are renewed through selected, stabilized discourses and “self–evidence” (Vadrot, 2013).

P-3317-06

Obstacles: Social practice in everyday life

B. Steffensen (1)

(1) University of Applied Sciences Darmstadt, Social Sciences and Social Work, Darmstadt, Germany

“Can the Green Economy save the climate?” The answer is simple at the moment – it is: No!

To explain the strict answer I tell a short story which happened during the turn of the year from 2012 to 2013. The story: I regularly buy a coffee in the cafeteria of our student union. In December 2012 I paid for a cup of cappuccino € 1.20. Coming back after Christmas Break I was looking forward to drink my regular morning cappuccino which now costs € 1.50. Astonished about the 25% price increase I asked the till girl: “What is the price of coffee higher now? She replied: “The students’ union executive body decided last autumn that they want us to provide fair trade coffee. Therefore you get a better coffee now and that makes it more expensive!” “Oh”, I said and started to think:

1. What is the price difference between a standard and a fair trade coffee?

2. How many cups of coffee does one get out of a 500gr-package of coffee?

A visit to my local supermarket revealed a price difference of about € 3.00 per package. Due to economies of scale the price difference is certainly smaller for the cafeteria. I calculated that a package of coffee will provide approximately 50 cups of cappuccino. The price increase for introducing fair trade coffee (by the way: the new and better coffee doesn’t really taste or look different) should be € 0.09. My conclusion: The student union tried to make an additional profit of € 0.24. Student’s protests led them to lower the price to € 1.35. Let’s accept that the additional € 0.09 covered a wage increase for the till girls. This is definitely not a scientific proof but it is an evidence for a practice of many firms.

Since the 1980 it is an established idea in the marketing literature that the green consumer will show up with increasing importance for producers and retailers. The growth rates during the last decade were due almost entirely to the marketing of green products was more or less a failure. But firms were successful in one aspect: Consumers are absolutely sure that green or sustainable products are inevitably more expensive than ordinary products. That the difference between ordinary and green products in many cases boils down to mere credence characteristics and only in some case to search or experience characteristics doesn’t make it easier.

The multi–level approval of the transitions theory (Geels; Kemp, Shove and others) as a transition process - i.e. towards a green economy – as a joint effort of a variety of different actors. It needs at least politicians, sometimes scientists, producers, retailers and consumers (individual households or firms in a supply chain) who have to act reciprocally and with a common interest without knowing for sure what the other will do: “do ut des!” Producers and retailers have to take entrepreneurial risks by producing “green” – consumers have to believe and trust in characteristics of products by consuming “green”. Our own research about environmental friendly products doesn’t reveal a lot of trust on both sides. In the transition from grey to greener (recognizable by labeling schemes) reciprocity seems to be crucial.

One important factor in the transition process is the aspect of culture which includes norms, daily routines and taken for granted. According to Anthony Giddens and others (Schatzki, Reckwitz, Bourdieu, Strengers, Wenger) we rely on social practices which are shaping our everyday actions. Decisions and actions of firms and individuals are based (1) on own experiences (formerly successful actions), (2) on recognized actions and decisions of relevant others, (3) on our expectations of the expectations of relevant others. Furthermore, the leeway to change behavior is (4) limited because preceding decisions and actions and changes might be costly.

Conclusion: The green economy is an ambitious project which requires a massive transition. To save the climate needs a shift of the mindset of the actors mentioned above. It requires a change of routines. To illustrate that: Considering the theory of practice as an option to conceptualize routine and somehow repetitive behavior the contribution shows limits and possibilities for actually generating a transition.

3318 - Sustainable strategies to mitigate climate and improve public health in developed and developing countries

ABSTRACT BOOK

ORAL PRESENTATIONS

K-3318-01

Norway’s knowledge platform on SLCFs – holistic thinking and multiple benefits for climate change and air quality

V. Vestreng (1) ; MM. Kvalevåg (1) ; S. Guttu (1) ; SF. Skjellum (1)

(1) Norwegian Environment Agency, Climate department, Trondheim, Norway

Short-lived climate forcers (SLCFs) are a relatively new field in a governmental context. In 2013, Norway published its first knowledge platform on SLCFs. The key objective was to perform an integrated assessment of climate, health and environmental effects of Norwegian emissions of SLCFs and propose measures and instruments for reducing such effects by 2030. Achieving the 2-degree target relies on substantial CO2 reductions. The Norwegian knowledge platform focuses on how measures targeting SLCFs could complement CO2 mitigation measures.

The scientific knowledge was quite immature and developed rapidly in parallel with the Norwegian Environment Agency’s assessment. This paper outlines methodology and challenges to be addressed in the future to establish a framework for the analysis of measures. The development of different reduction strategies for consideration by the Norwegian Ministry of Climate and Environment, and discussed. The choice of metric to compare the climate effect of different SLCFs was a key to our analysis. Development of national BC...
and OC emission inventories and valuation of health effects were other essential building blocks to enable an integrated assessment of measures. Calculation of the net climate effect of measures, i.e., taking into account both warming and cooling effects of emission reductions, is also important.

The results show that in the short term, the climate effect of Norwegian annual emissions of SLCFs is comparable to that of CO2. Measures aimed at SLCFs could delay increases in CO2 emissions in either the short or the long term, but reduced emissions of SLCFs will reinforce the global climate benefits of rapid reductions in CO2 emissions. Thus, both SLCFs and CO2 emissions could be regulated in order to reduce the rate of warming over the next decades.

In some cases, we found that measures with a positive health impact had a negative climate impact. Our study concludes that integrated approaches to assess climate change and air pollution may form a better basis for policy development. Currently, the Norwegian Environmental Agency is considering how the SLCFs best can be included in the analysis of greenhouse gas reductions.

K-3318-02

Improving health by acting on air pollution and climate change: the challenges faced by Chinese cities

T. Li (1)

(1) Chinese Center for Disease Control and Prevention, Institute for environmental health and related product safety, Beijing, China

As the most iconic example of the air pollution and climate change challenges of the world, China has experienced rapid economic expansion during the past decades which has led to a dramatic increase in emissions of both ambient pollutants and greenhouse gases. Heavy air pollution and temperature warming have been observed in China over the past century. China is also the biggest country for its population, and is confronted with the most vigorous aging population problem in the world. Global warming and aging are among 21st Century challenges. In addition, haze and heat are two major threats for public health in Chinese cities, as illustrated by the situation in Beijing. The haze pollution in Beijing became more and more serious in recent years. One of the worst episodes in January 2013 lead to significant excess mortality. Between January 17 to January 31, at least 164 persons died because of high PM2.5 concentrations. Respiratory and cardiovascular diseases are especially sensitive to PM2.5. Reducing PM2.5 could therefore significantly improved health and well-being in Chinese city.

We also investigated the health risk tradeoffs among heat, population aging, and adaptation under a changing climate by integrating the full range of the climate models. We estimated the exposure-response relationship between observed daily mortality of persons 65 years of age and older and the temperature data in Beijing. Then, we obtained downscaled future temperature projections from 31 climate models and two future representative concentration pathways (RCPs) scenarios for Beijing. These two inputs were then combined to estimate future mortality related to heat effects, which were compared to mortality in the baseline period.

Last, we incorporated population projections under three variant scenarios and the different heat adaptation scenarios to the above two inputs to project the changes of future heat-related mortality.

Under the population high variation scenario, in the 2080s and RCP8.5, Beijing was projected to experience a median of 15894 heat-related deaths per year of persons 65 years of age and older, which is approximately 6 times the projected value for the population without variation scenario. In the 2080s, with the biggest adaptation (under the 50% adaptation scenarios), the increase in heat-related death is approximately 7.4 times and 2.6 times larger than in the 1980s in RCP8.5 and RCP4.5 respectively.

Aging population will enlarge the heat-related health risk under the warming climate. Even under the high adaptation scenario, by the 2080s, the heat-related deaths would still increase. Our results provided evidence that adaptation would diminish the magnitude of future heat-related health risk, but not completely offset the heat impact from climate change. Our findings can lead to improved understanding of public health intervention policy making and underlining the dual problems of climate change and aging population.

O-3318-01

Mitigating air pollution to achieve health and climate benefits

P. Kinney (1)

(1) Columbia University, Mailman School of Public Health, Climate and Health Program, New York, NY, United States of America

Air quality is a major modifiable health burden around the world, especially in rapidly developing cities. Exposure to air pollution, including fine particles (PM2.5) and ozone, has adverse effects on human health throughout the lifespan. Adverse effects of air pollution include the development of chronic diseases such as lung cancer, chronic heart and lung diseases, as well as adverse effects on the reproductive system and on neuro-development. Action to mitigate air pollution brings immediate and lasting benefits for the health and well-being of the population. In addition, well-designed air pollution mitigation actions have the potential to reduce societal impacts on the climate system. In order to inform global, regional, and urban scale air pollution and climate planning, there is a need for multi-scale health impact assessments that estimate the potential health impacts and/or benefits that may result from coordinated mitigation strategies. We describe several such recent and ongoing efforts of this kind. For example, the recently-completed AC-HIA project estimated the influence that policies aimed at reducing air pollution emissions could have on global, regional, and local public health in 2030 and 2050 compared to 2010, taking into account the influence of climate change and alternative air pollution mitigation scenarios. Assessments were carried out across three different geographic scales, with increasing spatial granularity, for the entire world, for Europe, and for the Paris metropolitan region. To mitigation scenarios were evaluated: a business as usual scenario based on national regulations already on the books, and a maximum feasible reduction scenario. In general, health assessments carried out at finer spatial scales yielded greater health benefit estimates. This and other studies are pointing the way to a new generation of tools for integrated air quality and climate planning.

O-3318-02

Health and climate dual impact of African anthropogenic combustion aerosol emission change in 2030

C. Liouesse (1); L. Roblou (1); EM. Assamoi (2); M. Mallet (1); P. Criqui (3); C. Galy-Lacaux (1); R. Rosset (1)

(1) Laboratoire d’Aérologie, CNRS–Université Paul Sabatier UMR 5560, Toulouse, France; (2) University Felix Houphouet Boigny – Cocody, Abidjan, Physic, Abidjan, Ivory Coast; (3) CNRS and ANCRE, Pacte–eddn, Grenoble, France

Fossil fuel (traffic, industries) and biofuel (domestic fires) emissions of gases and particles in Africa are expected to significantly increase in the near future, particularly due to a rapid growth of African cities and megacities.

In this study, we will present the most recent developments of African combustion emission inventories, including African specificities. A regional fossil fuel and biofuel inventory for gases and particulates described in Liouesse et al. (2014) has been developed for Africa at a resolution of 0.25° x 0.25° for the years 2005 and 2030. For 2005, the original database of Junker and Liouesse (2008) was used after modification accounting for updated regional fuel consumption and emission factors. Two prospective inventories for 2030 are derived based on Prospective Outlook on Long-term Energy Systems (POLES) model (Criqui, 2001). The first one is a reference scenario (2030ref) with no emission controls and the second one is for a «clean» scenario (2030ccs) including Kyoto policy and African specific emission control. Our results
O-3318-03
The Importance of Revising Indonesia NAAQS for the Local Health Benefits and to Mitigate GHGs

H. Yulinawati (1)
(1) Universitas Trisakti, Jakarta, Indonesia

Indonesian government actively joins in efforts to reduce global GHGs emissions. Various regulations were issued such as Presidential Decree No. 61 of 2011 on the National Emission Inventory System and Presidential Decree No. 71 of 2011 on the National GHGs Inventory System. Unfortunately, local air pollution issues seem left behind, even until these days many big cities in Indonesia do not have an adequate integrated air quality management, such as limited emission inventory, the NAAQS is not well enforced, and lack of monitoring equipment. Black carbon (BC), a constituent of fine particulate matter (PM)10 and tropospheric ozone (O3) are harmful air pollutants associated with premature mortality that also contribute to global climate change. Recent study shows that BC and O3 emission reductions would have immediate and multiple benefits for human health. Therefore, policy designed to reduce GHGs can have co-benefits for air quality or vice versa. This study examines the current Indonesia NAAQS 1999 compared to WHO AQG 2005, mainly on particulate matter (PM) and O3. This study also evaluates ambient monitoring data of PM and O3, and Indonesia’s current emission control measures targeting BC and ozone precursor. By linking the three issues above, this study simulates the impacts of mitigation measures on ambient concentrations of PM2.5 and O3 to calculate their associated changes in health-related benefits. The WHO AQG 2005 for PM2.5: 10 μg/m3 annual mean; 25 μg/m3 24-hour mean, for O3: 150 μg/m3 annual mean; 65 μg/m3 24-hour mean. As comparison, Indonesia NAAQS 1999 for PM2.5: 15 μg/m3 annual mean; 50 μg/m3 24-hour mean. For PM10: 20 μg/m3 annual mean, 50 μg/m3 24-hour mean. As comparison, Indonesia NAAQS 1999 for PM2.5: 15 μg/m3 annual mean; 50 μg/m3 24-hour mean. For PM10: 20 μg/m3 annual mean, 50 μg/m3 24-hour mean. The WHO AQG 2005 provides interim targets as an approach to achieving the air quality guideline value. Indonesia, with higher levels of air pollution, should select a clear achievable interim target level based on air quality infrastructure. There is a substantial lack of monitoring stations for both PM2.5 and PM10; most monitored PM in Indonesia is only PM10. It is very necessary limited epidemiologic studies related to air quality too. Therefore, it is not easy to show the health benefits of mitigating emissions of air pollutants and GHGs. Some mitigations exist such as emission control for energy sector, transport sector, industrial plants, and population transportation, and relatively new discourse on low-carbon infrastructure. Revising Indonesia NAAQS is needed to make sure public health is guaranteed. Air quality and health co-benefits, because they have a mutually ancillary term, offer motivation for transformation to a low-carbon paradigm. It will be easier to set the target to mitigate the GHGs related to air pollutants.

O-3318-04
Health co-benefits and co-harms of reducing indoor air pollution in Sub Saharan Africa

R. Kawam (1)
(1) Institute of Public Health (IPH), Climate change and Health, Im Neuheimer Feld,324, heidelberg, Germany

Local air pollution harms health

Household use of solid fuel is the most widespread source of indoor air pollution worldwide. Globally, 2.6% of all ill-health is attributable to indoor smoke from solid fuels, nearly all in poor regions. Solid fuels are extensively used for cooking and home heating in developing countries, especially in rural areas. Solid fuel is usually combusted in inefficient cook stoves, producing a variety of health-damaging gases and particles, such as black carbon, organic carbon, methane, and carbon monoxide. More than 1.6 million deaths and over 35.8 million disability-adjusted life years (DALYS) were attributable to indoor smoke from solid fuels in 2000. Cooking with solid fuels is thus responsible for a significant proportion, about 3%, of the global burden of disease. Approximately 1.5 million deaths every year from respiratory infections can be attributed to the environment, including the effects of indoor air pollution. To encourage the use of cleaner burning fuels, the step is usually from wood to charcoal or kerosene and to Liquid Petroleum Gas might be effective ways to reduce air pollution exposures.

Reaping climate co-benefits by reducing climate active pollutants

Recent IPCC report stressed the role of many causative agents of indoor air pollution, as having in addition a greenhouse gas effect, in particular black carbon. Other common pollutants such as nitrogen oxide, sulfur dioxide, particulate matter and carbon monoxide have been shown to be associated with several adverse health events such as asthma attacks and incidence of chronic obstructive pulmonary diseases and lung cancer.

From a climate policy angle, reducing CAPs (Climate active pollutants) reduces Health Co-benefits. There are some evidences that stove improvements can substantially reduce indoor air pollution and the risk of lung cancer, respiratory diseases, Asthma, cataract, etc. Therefore, efforts should be made to reduce the burden of disease through public health and primary care programmes. Programmes can be designed to encourage urban and rural households that use solid fuels to move up the ‘energy ladder’ to cleaner fuels such as kerosene or liquid petroleum gas. Household changes to improve ventilation and behavioural modifications to reduce exposure could be the cost effective interventions to reduce the burden of diseases.

Avoiding co-harm

Co-harm is a negative health effect, which has never been mentioned in this context. Without smoke, indoor abundance of mosquitoes increases and there is a higher risk of malaria transmission. In the Sahel and Sahara region, plumes are transported from both the Sahara and Sahel towards West African Countries and cross the Atlantic Ocean. Predicting Dust haze generation should be an important environmental implications to develop new models in this area both for economic and social aspects. The main objective of the present study is to develop methodologies for better interpretation and use of NWP and Satellite products in forecasting Dust Haze generated.
Black carbon emissions from biomass and fossil fuels: Indo-Gangetic Plains, India

M. Arif (1) ; R. Kumar (2) ; E. Zusman (3)

(1) SHARDA UNIVERSITY, ENVIRONMENT SCIENCE, GAUTAM BUDDHA NAGAR, UP, India; (2) SHARDA UNIVERSITY, Environment science, GAUTAM BUDDHA NAGAR, India; (3) Institute for Global Environmental Strategies, Integrated policies for sustainable societies, Zushi, Japan

Most of the climate change debate and policies has focused on mitigating long-lived greenhouse gases (GHGs) to reduce global warming. But recently abating short-lived climate pollutants (SLCPs) such as black carbon (BC) has entered these discussions. BC emission from biofuel cooking in South Asia and its radiative forcing is a significant source of uncertainty for health and climate impact studies. Quantification of BC emissions in the published literature is either based on laboratory or remote field observations far away from the source. We use field measurements taken simultaneously inside urban and rural households (LPG and biomass users), ambient air and vehicular emissions from highways in area of the Indo–Gangetic-Plains region of India to establish the role of both solid biomass based cooking in traditional stoves, gas stoves and diesel vehicles in contributing to high BC. Household were also interviewed to understand barriers related to clean fuel accessibility and adoptability within users.

The major finding of this study till now is able to interpret the BC concentrations during cooking hours, both indoors and outdoors have anomalously large concentrations ranging from 3.82 µg to 105.64 µg for indoor during morning hours (05:00 to 09:00) and 1.32 µg to 130.7 µg for early evening hours (17:00 to 20:00). The BC emission during the non–cooking hours was also large, in the range of 1.05 to 95.44 µg. The peak outdoor BC concentrations are ranging from 6.54 µg to 40.81 µg in morning hours while 3.07 µg to 27.92 µg in evening hours. BC emission from transportation was also found high in morning and evening hours with large concentration reaching 4.38 to 52.12 µg in morning hours and 1.71 to 49.02 µg in evening hours. The imprint of the cooking hour peaks were seen in the outdoor BC both in the village as well as in the highway. The results have significant implications for climate and epidemiological studies.

The Fertilizer and Carbon Sequestration Potential of an Accelerated compost in two soil types

OE. Ayanfeoluwa (1) ; VO. Aduramigba, (2) ; O. Adeoluwa, (3)

(1) Federal College of Agriculture, Department of Crop production, Ibadan, Oyo State, Nigeria, Federal Republic of; (2) Institute of Agricultural Research and Training, Department of land and water resources, Ibadan, Oyo State, Nigeria, Federal Republic of; (3) University of Ibadan, Department of agronomy, Ibadan, Oyo State, Nigeria, Federal Republic of

Compost has the potential to trap carbon in the soil while supplying the nutrients needed for the crop use. This study therefore investigated the fertilizer and carbon sequestration potential of an accelerated compost (a new commercial compost from market organic wastes and animal manure with composting accelerated with a specific microorganism). This experiment was laid out in Randomized Complete Block Design with three replications. The treatments were accelerated compost (AC) at the rate of 60, 90, 120, 150 and 180 kg N / ha. The mineral fertilizer (NPK 15–15–15) and conventional compost (CC), both at 60 kg N / ha, as well as the control (no soil additive) were the checks. Data were collected on the maize grain yields at both main and second cropping and post cropping soil organic carbon. Data were analysed using Analysis of variance and means compared with standard error of means. The result of the grain yield at the main planting showed that, on an Alfisol, the 60 kg N / ha AC resulted into significantly higher grain yield (3.41 t / ha) than the 60 kg N / ha NPK (2.79 t / ha) and 60 kg N / ha CC (2.76 t / ha). On an Ultisol, the 60 kg N / ha AC resulted into significantly higher grain yield (3.41 t / ha) than the 60 kg N / ha NPK (2.79 t / ha) and 60 kg N / ha CC (2.74 t / ha). At the residual planting, on an Alfisol, both the 60 kg N / ha AC (2.31 t / ha) and 60 kg N / ha CC (2.41 t / ha) performed significantly higher than the 60 kg N / ha NPK (2.21 t / ha), while the same trend was observed on an Ultisol. The AC sequestered more carbon (58 % extra compared to the control) than the CC (9 % extra compared to the control) at the same 60 kg N / ha rate on an Alfisol. Also on an Ultisol, Accelerated compost sequestered more carbon (14 % extra compared to the control) than the CC (5 % extra compared to the control) at the same 60 kg N / ha rate. It could therefore be concluded that the shortness in maturity of accelerated compost does not limit its fertilizer and carbon sequestration potential.

Modélisation de l’impact de la pollution atmosphérique urbaine aux échelles régionale et locale en Afrique de l’Ouest

D. Madina (1)

(1) university Félix Houphoôt Boigny, Physic, Cocody, Abidjan, Ivory Coast

Regional climate modeling of the impact of urban air pollution at regional and local scales in West Africa

Mainly based on modeling, this study will highlight the impact of particulate and gaseous pollution from the West African megacities on regional climate and urban meteorology. The West African region has very large cities which promote strong anthropogenic urban air pollution.

Using the Regional Climate Model (RegCM4) at the scale of West Africa will permit focus on the impact of urban air pollution on the climate of this region. Knowing that megacities affect their environment at local scales, up to the street, where RegCM4 is no more suitable, the Weather Forecast Research and its chemistry module (WFR–CHEM) with finer resolution will be used to study the chemistry of pollutants in the megalopolis. This part will focus essentially on aerosols (BC, OC, SO4 and NO3) and gases (CO2, CO, SO2 and VOC) combustion.

In the preliminary result, we have activated the dusts module to see what it brings disturbance on climate parameters. The tests with the model RegCM reproduce well the patterns of precipitation. Also we compare the temperature of the model with and without chemistry with observations. Thus the presence of dusts has a cooling effect and tends to improve the system. In further work we will characterize the products of air pollution from Abidjan and Lagos. First, it will be for me to refine the inventories of particulate emissions in two megacities of West Africa (Abidjan and Lagos). Also analyze the impact of particulate and gaseous pollution on regional and local climate, while using the WRF_CHEM model for urban study.
ORAL PRESENTATIONS

O-3320-01

The global and regional health impacts from future food production under climate change

M. Springmann (1); D. Mason-D’croz (2); S. Robinson (2); P. Ballon (3); T. Garnett (4); C. Godfray (5); D. Gollin (6); M. Rayner (7); P. Scarborough (7)

(1) University of Oxford, Department of Population Health; Oxford Martin Programme on the Future of Food, Oxford, United Kingdom; (2) International Food Policy Research Institute (IFPRI), Washington DC, United States of America; (3) Universidad del Pacifico, Department of economics, Lima, Peru; (4) University of Oxford, Environmental change institute, Oxford, United Kingdom; (5) University of Oxford, Department of zoology, Oxford, United Kingdom; (6) University of Oxford, Department of international development, Oxford, United Kingdom; (7) University of Oxford, British heart foundation centre on population approaches to non-communicable disease prevention, Oxford, United Kingdom

Background: One of the most important consequences of climate change could be its impact on agriculture. While much research has focused on questions of food security, less attention has been devoted to assessing the wider health impacts of future changes in agricultural production. We estimate excess mortality due to agriculturally mediated changes in dietary and weight-related risk factors by cause of death for 155 world regions in the year 2050.

Methods: We linked a detailed agricultural modelling framework, the International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT), to a comparative risk assessment of changes in fruit and vegetable consumption, red–meat consumption, and body weight for deaths from coronary heart disease, stroke, cancer, and an aggregate of other causes. We calculated the change in the number of deaths due to climate–related changes in weight and diets for the combination of four emissions and three socioeconomic pathways, which each included six scenarios with variable climatic inputs.

Findings: The model predicts that by 2050 climate change will lead to per-capita reductions of 3%, 4%, and 1% in global food availability, fruit and vegetable consumption, and red–meat consumption, respectively. Those changes were associated with a 6%–15% decline in fruit and vegetable consumption deaths globally (95% CI: 314,000–736,000), representing a 28% reduction in the number of deaths that would be avoided due to changes in dietary and weight–related risk factors between 2010 and 2050. Twice as many climate–related deaths were associated with reductions in fruit and vegetable consumption than with climate–related increases in the prevalence of underweight, and most climate–related deaths were projected to occur in South and East Asia. Adopting climate–stabilization pathways reduced the number of climate–related deaths by 29–71% depending on their stringency.

Interpretation: The health impacts of climate change from changes in dietary and weight–related risk factors could be significant, and exceed other climate–related health impacts that have been estimated. Climate change mitigation could prevent a substantial number of climate–related deaths. Strengthening public–health programmes aimed at preventing and treating diet and weight–related risk factors could be a suitable climate change adaptation strategy.

O-3320-02

Understanding the impact of international climate policies on regional food security using an Integrated Assessment Model

Y. Cui (1); S. Waldoﬀ, (2); E. Gilmore (1)

(1) University of Maryland, School of public policy, College Park, MD, United States of America; (2) NET Global Change Research Institute, PNNL, College Park, MD, United States of America

We evaluate changes to regional food security under different international climate policy structures using an integrated assessment (IA) model, the Global Change Assessment Model (GCAM). Climate change mitigation policies may affect food security through complex interactions of changing food prices by altering land use patterns and changing income by inﬂuencing economic development and poverty reduction. IA models provide a consistent framework for evaluating these effects using assumptions that are consistent with the estimates of the costs and other impacts of climate policies.

First, we develop a measure of food security that can be estimated in GCAM based on economic accessibility and nutritional value. Specifically, national and regional food accessibility is approximated by the fraction of income spent on staple commodities, weighted by total food calorie availability and the share provided by staples. To better capture regional variability, we develop this measure by estimating regional consumer prices of staple commodities from the global producer prices modeled in GCAM. Second, we evaluate the implications over different socioeconomic scenarios, represented by the Shared Socioeconomic Pathways (SSPs). Finally, we estimate the impact of a universal carbon tax (UCT) on greenhouse gas (GHG) emissions to reach global climate targets reﬂected by the Representative Concentration Pathways (RCPs), without and with transfer payment using two illustrative allocation regimes.

We ﬁnd that the socioeconomic pathway and the climate policy regime have important implications for food accessibility. More optimistic SSPs generally improve food accessibility with greater marginal beneﬁts in poor and already food insecure regions. Second, impacts on food accessibility caused by a UCT mitigation policy differ across regions with greater impacts in developing countries. Third, regional variability of food access is further modiﬁed with payment transfers in global carbon trading. In particular, an allocation regime based on future population is expected to favor developing regions and thus moderate regional inequality of food access, while an allocation regime based on historical emissions tends to exacerbate the cross–region variability.

By exploring the magnitude and distribution of impacts on food security under alternative climate policy scenarios, we capture an important dimension of regional impacts of climate policy beyond mitigation costs.

Acknowledgement: This material is based upon work supported in part by the U.S. Army Research Laboratory and the U.S. Army Research Ofﬁce via the Minerva Initiative under grant number W911NF-13-1-0307.

O-3320-03

Household and food security: what lessons can we learn from food secure households?

S. Silvestri (1); S. Douxchamps (2); P. Kristjansdottir (3); W. Foorch (0); M. Radeney (4); I. Mutie (1); C. Quiros (1); H. Mario (5); A. Ndungu (3); N. Ndiwa (1); J. Mangu (3); L. Claessen (6); M. Rufino (7)

(1) International Livestock Research Institute, Nairobi, Kenya; (2) International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Ouagadougou, Burkina Faso; (3) World Agriculture Centre (ICRAF), Nairobi, Kenya; (4) ILRI, CCAFS East Africa, Nairobi, Kenya; (5) Commonwealth Scientiﬁc and Industrial Research Organisation (CSIRO), QLD, Australia; (6) International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Nairobi, Kenya; (7) CIFOR / CCAFS, Nairobi, Kenya

The potential impacts of climate change on food security in East Africa, while complex and variable due to highly heterogeneous landscapes, are a cause of concern. How well people are able to adapt to, or reduce climate change effects will depend on whether they are able to...
change their behaviour and adopt improved agricultural technologies and management strategies.

While there is a rapidly growing literature on vulnerability and adaptation to increased climatic variability and climate change, significant knowledge gaps still exist, especially regarding the assessment of adaptation options in different environments and how these might be appropriately targeted to different types of households to reduce food insecurity.

This study therefore addresses a series of questions, such as: what are the key factors that contribute to household-level food security; what lessons can we learn from food secure households; and what agricultural interventions, options and management strategies are likely to benefit female-headed households in particular. It uses a unique dataset of 600 households to explore a wide range of indicators capturing different aspects of household performance and well-being for different types of households (female-headed, male-headed, food secure, food insecure) and assess livelihood options and strategies and how they influence food security. The analysis is based on a very detailed farm characterisation survey carried out in three sites in Kenya, Uganda and Tanzania.

The results of this study show that food secure farmers appear to be the ones that diversify the most variety of crops on their farms and are market oriented. In addition, domestic asset increases the likelihood of being food secure for female headed households. Yet, a different literature provides evidence that women-headed and female head of household, with women less likely to grow high-value crops then men and with a less diversified crop portfolio.

These findings can inform the targeting of national and regional policies to enhance adaptation in agricultural smallholder systems of East Africa. Implications of these findings include identifying actions that are likely to contribute more to food security and that can better enhance food security for female-headed as well as male-headed households. These usually include interventions that enable households’ access to information about new technologies and practices especially though innovative communication effort, and new market opportunities.

**P-3320-04**

**IPCC AR5’s contribution to the understanding of the future of fisheries and aquaculture and the knowledge gaps that have yet to be covered**

A. Seggel (1); D. Soto, (2); C. Deyoung (2); T. Bahri (2)

(1) FAO, Fisheries and aquaculture department, Rome, Italy;
(2) FAO, Fisheries and aquaculture, Rome, Italy

The IPCC AR5 provides highly relevant knowledge on the future implications of climate change on global fisheries and aquaculture resources. This presentation sets out to highlight how the IPCC AR5 contributes to the discussion on climate change and its direct and indirect effects on fisheries and aquaculture, our understanding of vulnerabilities within the sector and dependent communities and economies, and adaptation and mitigation options from within the sector. Furthermore, it will identify knowledge gaps of the IPCC AR5 that remain to be covered as well as provide additional knowledge not yet captured by the AR5. The presentation will provide examples of vulnerability questions and methodologies being applied from within the sector, covering inland, marine fisheries and aquaculture systems. Concrete examples of how fishers, aquaculture farmers, post-harvest systems and dependent communities are perceiving and reacting to climate variability and change will be shared. Filling knowledge gaps and up-scaling our efforts are important in order to better comprehend how food, nutrition and livelihood security as well as economic growth objectives from fisheries and aquaculture are required to change in order to be climate smart.

The abstract is submitted on behalf of the Global Partnership for Climate, Fisheries and Aquaculture (PaCFA).

**P-3320-01**

**Climate change impacts on the leaf miner, a major pest of the oil palm in Nigeria**

T. Aneni (1)

(1) Nigerian Institute for Oil palm Research, Benin, Edo, Nigeria, Federal Republic of

This study examines application of climate variability to abundance and impacts on the leaf miner, Coelaenomenodera elaeidis, a major pest of the oil palm and its parasitoids in Africa. It analyses temperature, rainfall and relative humidity conditions from 1961 – 1970, as a reference point for baseline climatic conditions and description of same conditions between 2001 – 2010; Evaluates projections up to 2050; and describes impacts on leaf miner abundance. Leaf miner was sampled in the main station of the Nigerian Institute for Oil palm Research, between January 2009 and December 2010. Means, standard deviation, variances, covariance’s, seasonal and climatic patterns for temperature, rainfall and relative humidity were computed. Least square method was used to estimate the trend in the series and the trend equation. Time series analysis was used to analyse the data and generate trend equations. The models for temperature, rainfall, and these findings include identifying actions that are likely to benefit female-headed households in particular. It uses a unique dataset of 600 households to explore a wide range of indicators capturing different aspects of household performance and well-being for different types of households (female-headed, male-headed, food secure, food insecure) — and assess livelihood options and strategies and how they influence food security. The analysis is based on a very detailed farm characterisation survey carried out on in three sites in Kenya, Uganda and Tanzania.

The results of this study show that food secure farmers appear to be the ones that diversify the most variety of crops on their farms and are market oriented. In addition, domestic asset increases the likelihood of being food secure for female headed households. Yet, a different literature provides evidence that women-headed and female head of household, with women less likely to grow high-value crops then men and with a less diversified crop portfolio.

These findings can inform the targeting of national and regional policies to enhance adaptation in agricultural smallholder systems of East Africa. Implications of these findings include identifying actions that are likely to contribute more to food security and that can better enhance food security for female-headed as well as male-headed households. These usually include interventions that enable households’ access to information about new technologies and practices especially though innovative communication effort, and new market opportunities.

**P-3320-02**

**Mapping irrigation potential from renewable groundwater in Africa: a quantitative approach**

Y. Altchenko (1); K. Villholth (1)

(1) International Water Management Institute, Southern Africa Office, Silverton, South Africa

Groundwater provides an important buffer to climate variability in Africa. Yet groundwater irrigation contributes only approximately 1% of the cultivated land as compared to 14% in Asia. As opposed to previous country-based estimates, this paper derives a continent-wide, distributed (0.5 degree resolution) map of groundwater irrigation potential, indicated in terms of fractions of cropland potentially irrigable with renewable groundwater. The method builds on an annual groundwater balance approach using 41 years of model data, allocating to groundwater irrigation the groundwater recharge in excess after satisfying other current human needs and environmental requirements, while disregarding any socio-economic and physical constraints in access to the resource. Due to high uncertainty of groundwater environmental needs, three scenarios, leaving 30, 50 and 70% of recharge for the environment, were implemented in a conservative estimate of the potential. In addition, current dominating crops and cropping rotations and associated irrigation requirements in a zonal approach were applied. Results show an inhomogeneously distributed gross groundwater irrigation potential across the continent, even within individual countries, reflecting recharge patterns and extent of cropland. Results further show that average annual groundwater available for irrigation ranges from 708 to 1669 km3 depending on scenario. The total area of cropland irrigable with groundwater ranges from 44.6 to 105.3 million hectares, corresponding to 20.5% to 48.5% of the cropland over the continent. Accounting for existing groundwater irrigation, residual irrigation potential remains high and relevant for poverty alleviation in the Sahel and Eastern Africa region where climate variability could have important impact on population. This could significantly increase the food production and productivity in the region from a reliable and renewable resource.

**P-3320-03**

**Dynamics in climate change, agriculture and food security in the sub-saharan Africa: a review**

MA. Awodun (1)
There have been decreases in food supply caused by extreme weather events. Regardless of where extreme weather events affect the ability and income of farmers to buy and sell food, the impacts are disproportionately felt by the world’s poor. Moreover, crop failures due to extreme weather not only affect those buying and selling in the global market, but also have a direct impact on subsistence farmers. Understanding how such extreme weather events—which are predicted to become more frequent under climate change—will affect both yields and total production of the world’s staple food crops is therefore an urgent scientific challenge. Climate change is occurring more rapidly than anticipated and the increase in extreme weather events threatens more disruptive effects to agriculture. The vulnerability of food production systems has been demonstrated over and over again. Food security is the state achieved when food systems operate such that all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life. Food security is underpinned by food systems and is diminished when food systems are stressed. This stress can be caused by a range of factors in addition to global environmental change (e.g. population pressure, changes in international trade agreements and policies, migration) and may be particularly severe when these factors act in combination. Agriculture contributes on average 34 percent to the GDP of Sub-Saharan Africa (SSA) countries and employs 64 percent of the labour force. It accounts for about 40 percent of exports and provides various ecosystem services. Agriculture and rural development are thus the key pillars of the SSA economy. Sub-Saharan Africa is characterized by a growing population (2–3%) and an increasing number of food insecure households due to farming activities. Soil degradation due to population pressure, intrinsic soil fragility and harsh climatic conditions have decreased the amount of cultivable land per capita and led to food insecurity since farmers have very limited means to purchase agricultural inputs (mineral and/or organic manure, working tools, and technical capacities, etc.) to increase soil productivity. Review of average crop yield for cereals, roots and tubers in 41 African countries showed 13 countries registering decline in cereals yield and 15 registering decline in yields for roots and tubers. Decline in rainfall has significantly altered the traditional farm calendar and soil degradation overstretched local farmers’ soil management capability. Population resilience to these changes are related to several coping and adaptive strategies including crop diversification, mobility, livelihood diversification and migration. Adaptation which is a process of adjusting to a changing climate through explicit and planned interventions, or spontaneous consequence of inherent flexibility, can mitigate the impacts of climate change. While adaptation to climate change has been seen by most observers as the most preeminent issue for African countries. There is a strong parallel development of initiatives that aim at stabilizing GHG concentration in the atmosphere (mitigation); in reality, mitigation and adaptation should not be pursued independently as they are complementary. Most mitigation options will reduce impacts of climate change and several adaptation strategies will lead to a reduction of GHG disposal in the atmosphere. With the slow progress in achieving mitigation, it is suggested that a viable option of adaptation is developed to prevent the anticipated negative impacts of global climate change. Conservation agriculture, which involves minimal soil disturbance can improve water use efficiency by crops and helps in carbon sequestration processes and also improve on the capacity of crops to withstand weather stresses. Successful production using high input, high water intensive irrigation will likely be the key to ensuring food security as weather pattern shift.

P-3320-04
Sustainable Agriculture and Climate Change: Producing Potatoes (Solanum tuberosum L.) and Bush Beans (Phaseolus vulgaris L.) for Improved Food Security and Resilience in a Canadian Subarctic First Nation Community
C. Barbeau (1); M. Oelbermann, (1); J. Karagatzides, (2); L. Tsuji, (3)
(1) University of Waterloo, Environment and Resource Studies, Waterloo, Ontario, Canada; (2) Georgian College, School of environmental studies, Barrie, Canada; (3) University of Toronto, Health studies and the department of physical and environmental sciences, Scarborough, Canada

Aboriginal people in Canada’s northern regions are vulnerable to climate variability in addition to experiencing disproportionately high rates of diet-related illnesses including obesity, diabetes, and heart disease. Food insecurity is a contributing factor along with a loss of traditional lifestyles. Current food systems within these regions rely heavily on imported foods that are expensive (when available), and unsustainable. A warming subarctic and arctic climate offers the opportunity for local agricultural production initiatives that can increase food security and promote a more sustainable food system. In this study the feasibility of sustainably growing potatoes (Solanum tuberosum L.) to enhance food security in remote subarctic communities is explored through a case study in Fort Albany First Nation in northern Ontario, Canada. Potato crops were grown over a two-year period and rotated into plots that had been planted with green bush beans (Phaseolus vulgaris L.). Results showed that potatoes and bush beans could be grown successfully in the subarctic with yields comparable to more traditional agricultural methods. In subarctic Canada, sustainable local food production helps to promote social capital, healthier lifestyles, and food security.

P-3320-05
Weather, Climate and Food Security
T. Beer (1)
(1) President, IUUG Union Commission on Climatic and Environmental Change, CSIRO; P81, Aspendale, Vic., Australia

Safety and Security, though almost synonymous opposites of “risk,” can have different meanings. Thus, for example, food safety is only one of the nine attributes of food security.

To meteorologists, food security is dominated by the impacts of weather and climate on food systems. But the link between the atmosphere and food security is much more complex. Extreme weather events such as tropical cyclones impact directly on agriculture, but they also impact on the logistical distribution of food and can thus disrupt the food supply chain, especially in urban areas. A holistic approach is required to understand the phenomena, to forecast catastrophic and to predict their societal consequences.

In the Food Security recommendations of the Rio+20 Forum on Science, Technology and Innovation for Sustainable Development it states that it is important to understand fully how to measure, assess and reduce the impacts of production on the natural environment including climate change, recognizing that different measures of impact (e.g. water, land, biodiversity, carbon and other greenhouse gases, etc) may trade-off against each other.

The International Union of Geodesy and Geophysics (IUGG), through its Union Commission on Climatic and Environmental Change (CCEC) is leading the WeatherIFS consortium of international scientific unions to examine weather, climate and food security as well as to look at the interaction of food security and geophysical phenomena. The following fundamental question underpins WeatherIFS: What technologies and methodologies are required to assess the vulnerability of people and places to hazards (such as famine) – and how might those be used at a variety of spatial and temporal scales? This poster will review the work undertaken to date.

P-3320-06
International Joint Laboratory Patho-Bios, an efficient observatory of Plant Pathogens in West Africa in the context of climate change
C. Brugidou (1); E. Traoré (2); F. Tiendrébéogo (3); J. Neya (3); D. Serême (3); I. Wonni (4); M. Bangratt (3); C. Tembiere (5); L. Nitiema (6); P. Nikiema (6); E. Zida (6); L. Ouedraogo (4); S. Nacro (6); O. Traoré (6)
(1) IRD, Département Environnement Ressources, Montpellier, France; (2) INERA, Ouagadougou –Kamboïnse, International Scientific Conference 7-10 JULY 2015 PARIS, FRANCE
The International Joint Laboratory (LMI) entitled observatory of Plant Pathogens in West Africa: Biodiversity and Biocare safety (LMI–Patho–Bios) has been formally launched in Burkina Faso on the 30th January 2014. LMI–Patho–Bios was initiated by the national research institute of Burkina faso, “Institut de l’Environnement et de Recherches Agricoles (INERA)” and the French Research Institute for Development (IRD) which have signed a memorandum of understanding to drive five main research axes focused on bio surveillance of plant pathogens. LMI–Patho–Bios is established at INERA on two sites. It is mainly located at Kamoinshe research station of INERA (Ouagadougou) with a secondary location at St. Dioulasso. LMI–Patho–Bios is interested on all important crops in West Africa including cereal crops (rice, maize, sorghum, millet), root and tuber crops (yam, cassava, sweet potato) and legume crops (peanut, groundnut, beans, lentils). Its main goal is to develop a powerful open field observatory platform for bio surveillance in order to study plant pathogens interactions, diversity and evolution of pathogen populations in the context of global warming which is expected to lead to major changes in plant diseases epidemic risks. Rice is used as model crop in such a platform which will significantly contribute for better understanding of the emergence of new and re-emerging diseases in a context of continuing climate change. Surveys will be made on common experimental plots located in different agroecological area in Burkina Faso and in West Africa to follow the dynamics and aggressiveness of pathogen populations. The major activities consist on diagnosis and characterization of plant bio-aggressors as well as epidemiology study of rice pathogens: viruses (RYMV, RSVN), bacteria (Xanthomonas oryzae, Burkholderia sp), fungi (Magnaporta grisea), and nematodes (Meloidogyne spp.). LMI–Patho–Bios has also developed a strong regional network with several national research systems (NARS) and Universities in Sub-Saharan Africa (SSA) and contribute in the capacity building of researchers, research technicians, students and agricultural extension officers. Finally, the joint laboratory will train and promote knowledge dissemination to farmers and extension officers on good agricultural practices in terms of recognition and proper management of bio-aggressors. Furthermore, LMI–Patho–Bios will contribute to develop strategic technological tools to help African farmers to better adapt to, and to mitigate the effects of climate change.

P-3320-07

Post harvest challenges & economic consequences and opportunities. Case study of Rwanda

H. Cesar (1); T. Doucha (1); T. Ratering (1)
(1) Czech University of Life Sciences in Prague, Economic and Development, 16500 Praha 6, Suchodol, Czech Republic

The total agricultural product loss of 23.5% in Rwanda is due to poor post–harvest processing of agricultural products, when valued in monetary terms reflects a tremendous impact caused by post harvest losses by quantifying the level of impact of post harvest losses damages to evaluate the economic loss caused by this damage.

P-3320-08

For a sustainable agriculture according to land suitability, dietary needs and climate scenarios

A. Di Paola (1); MC. Rulli, (2); M. Santini (3)
(1) Euro–Mediterranean Center on Climate Change (CMCC), Impacts on Agriculture, Forests and Ecosystem Services (IAFES), Viterbo, Italy; (2) Politecnico di Milano, Department of civil and environmental engineering, Milano, Italy; (3) Centro Euro–Mediterraneo sui Cambiamenti Climatici, Impacts on agriculture, forests and ecosystem services, Viterbo, Italy

A large portion of agricultural production is funneled into animal feed or biofuels despite widespread hunger and undernutrition. Predictions foresee global demand for biofuels increasing from 81 billion of litres in 2008 to 172 billion litres in 2020, coinciding with an additional 40 million hectares of land converted for biofuel crops. According to the Milan protocol (http://www.milanprotocol.com/), a third of the global food production is used directly to fuel people. Of the seven 7 billion people on earth, 1 billion are without access to drinking water, which causes the death of 4,000 children each day. In contrast, 15,000 litres of water are needed for the production of a single kilogram of beef. This study assesses the advantages and feasibility of options to optimize the production, promotion and distribution of food with a high protein content (so as to remain equal nutritional quality of the meat) to reduce the footprint of water consumption and GHGs’ emissions from the agricultural sector and to recover the availability of agricultural land as well. As example it is recognize that if the same amount of plant protein produced from protein-rich legumes is used directly for human consumption rather than for feed (currently 95%) up to 75 times the land currently required to grow feed crops could be recovered, up to 40 -103 cubic meters of water could be recovered and, also, emissions should be contained thanks to the nitrogen-fixing behavior of promising rich-crops. By means of crop modeling coupled with emission–climate and diet scenarios, and adopting an ensemble approach that favors robust evaluations comprehensive of uncertainty flagging, we show how it is possible to forecast different dietary adjustment strategies and how to ensure that agricultural growth is compatible to land suitability, water availability, dietary needs and climate projections. In particular, agricultural options we investigate include i) identification of protein-rich legumes for human consumption according both with the current and projected climate, ii) their contribution to limit environmental footprints (GHG, water, land) and iii) the optimal compromise of crop production used for human consumption vs feed such as to ensure a balanced diet between meat and lacto-ovo-vegetarian consumption compatible to climate change, water consumption and land recovery issues.

P-3320-09

Predetermination of floods in the Senegal River Valley: application between Bakel and Matam

Y. Dieme (1); S. Sambou (2); VB. Traoré (2); MT. Cissé (1); C. Diatta (2); M. Bop (1)
(1) Laboratoire Hydraulique et Mécanique des Fluides /FST/UCAD, Physique, Dakar, France; (2) Laboratoire Hydraulique et Mécanique des fluides, Physique, Dakar, Senegal

The risk of flooding in the valley of the Senegal River remain important. These floods more and more recurrent can be explained by a combination of unusual climatic events. Extreme severe summer and winter conditions cause the death of 4,000 children each day. In contrast, 15,000 litres of water are needed for the production of a single kilogram of beef. It is recognize that if the same amount of plant protein produced from protein-rich legumes is used directly for human consumption rather than for feed (currently 95%) up to 75 times the land currently required to grow feed crops could be recovered, up to 40 -103 cubic meters of water could be recovered and, also, emissions should be contained thanks to the nitrogen-fixing behavior of promising protein-rich crops. By means of crop modeling coupled with emission–climate and diet scenarios, and adopting an ensemble approach that favors robust evaluations comprehensive of uncertainty flagging, we show how it is possible to forecast different dietary adjustment strategies and how to ensure that agricultural growth is compatible to land suitability, water availability, dietary needs and climate projections. In particular, agricultural options we investigate include i) identification of protein-rich legumes for human consumption according both with the current and projected climate, ii) their contribution to limit environmental footprints (GHG, water, land) and iii) the optimal compromise of crop production used for human consumption vs feed such as to ensure a balanced diet between meat and lacto-ovo-vegetarian consumption compatible to climate change, water consumption and land recovery issues.
and of infrastructure. The determination of flood risk areas is important to anticipate and protect populations. For this we used coupled models HECRAS and ARC‐GIS to determine the areas likely to be flooded between Bakel and Matam. These flood risk were studied with decennial, centennial and millennial flows. The results are promising and suggest that HE‐RAS with ArcGIS can be used to set up an early warning system on the Bakel, Matam reach.

P-3320-10

Modelling the current and future dry‐sea‐son distribution of Encosternum delegorguei (Hem., Tessaratomidae) in sub‐Saharan Africa

C. Dzeresof (1); E. B. (1); W. E. (1); G. D. (2)

(1) University of the Witwatersrand, School of Animal, Plant and Environmental Sciences, Johannesburg, South Africa; (2) SANBi, Climate change and bio‐adaptation division, Cape Town, South Africa

Rural communities in South Africa, Malawi and Zimbabwe annually harvest from winter aggregations of the edible stinkbug Encosternum (=Haplosterna) delegorguei. Spinosia. Using a regional maximum entropy modelling method (MAXENT) for winter field records of E. delegorguei, current and future climate scenarios were identified. Winter precipitation and to a lesser degree summer precipitation and winter temperature were the climatic variables found to limit the current regional distribution of E. delegorguei. The receiver operating characteristic analysis (ROC) yielded an AUC (area under the curve) value of 0.995, indicating a reliable model although interpretations must consider the influence of variables for this insect species. A testable hypothesis regarding future distribution of E. delegorguei in the face of climate change has been formulated for its winter range. Predator–prey relationships and food source are also influencing the occurrence of E. delegorguei and may override the influence of climate. The modelled current distribution identifies potential new sites in areas of similar climate which may be unknown to harvesters. Areas for mini‐livestock pilot studies provide opportunities for extending commercial potential and ensuring a sustainable nutritional food during a period of food scarcity.

P-3320-11

Economic implications of climate change in Sub-Saharan agricultural system: short term impacts and opportunities for irrigation

F. Eboli (1); F. Bosello (2); L. Campagnolo (3); M. Mistry (4); R. Parrado (5); RD. Ponce (6)

(1) Euro‐Mediterranean Center on Climate Change, Economic analysis of Climate Impacts and Policy Division, Venice, Italy; (2) University of Milan, FEEM, and CMCC, Dep. of economics, Milan, Italy; (3) Fondazione Eni Enrico Mattei, Venice, Italy; (4) Ca' Foscari University and FEEM, Department of economics, Venice, Italy; (5) FEEM, Venice, Italy; (6) Ca' Foscari University of Venice, Economics, Venice, Italy

This research examines the climate related impacts and adaptation options in Sub-Saharan African agriculture in a recursive dynamic Computable General Equilibrium (CGE) framework with world coverage. Different from past of the global CGE models treating the land supply in a very simplistic way, here we introduce land heterogeneity in Sub-Saharan African agriculture. Using a regional maximum entropy modelling method (MAXENT) for winter field records of E. delegorguei, current and future climate scenarios were identified. Winter precipitation and to a lesser degree summer precipitation and winter temperature were the climatic variables found to limit the current regional distribution of E. delegorguei. The receiver operating characteristic analysis (ROC) yielded an AUC (area under the curve) value of 0.995, indicating a reliable model although interpretations must consider the influence of variables for this insect species. A testable hypothesis regarding future distribution of E. delegorguei in the face of climate change has been formulated for its winter range. Predator–prey relationships and food source are also influencing the occurrence of E. delegorguei and may override the influence of climate. The modelled current distribution identifies potential new sites in areas of similar climate which may be unknown to harvesters. Areas for mini‐livestock pilot studies provide opportunities for extending commercial potential and ensuring a sustainable nutritional food during a period of food scarcity.

The first step of the analysis is the assessment of the climate change impacts. The reference scenario is the SSP5, to ensure consistency with the climate scenario described below. It is worth mentioning that the time frame of the analysis is 2050, even though climate change impacts are expected to increase more than proportionally later than 2030. However, adaptation strategies imply decisions in the very short term and can lead to delay in taking actions against future climate change. For the impact assessment, two climate scenarios in line with RCP8.5 are analyzed. The first assumes constant CO2 (1960 level, 316.27 ppm), while the second scenario CO2 increase over time mirroring RCP8.5 concentration. Biophysical changes in land productivity by crop and land type are taken by the LPJ‐ML model run according to the Can‐Eld General Circulation Model and are exogenously introduced in the CGE model.

Without “CO2 fertilization effect”, due to the short term considered, a few countries/regions, namely Nigeria, Senegal, Madagascar, Botswana and Rest of West Africa are better off in terms of agricultural production; on the other hand, Malawi, Mozambique and the Rest of South Central Africa are the most affected countries in terms of yields reduction. Where agricultural production drops, the dependence from imports increases, clearly highlighting the effects of economic vulnerability to climate change. The overall effect on Sub-Saharan African economies is summarised by the GDP growth change compared to the reference scenario and ranges between –1.6% (Mozambique) and +1.6% (Nigeria). The “CO2 fertilisation effect” scenario has a more heterogeneous impact on yields. Mozambique is the only country with production losses in all agricultural sectors compared to the reference scenario. The impact on GDP is generally positive; only Mozambique and the Rest of South Central Africa experience a GDP loss of 0.6 and 1.1%, respectively.

Overall, when the “CO2 fertilization” effect is not accounted for, Eastern and South Central Africa experiments negative changes in yields also in such a short time horizon. Extending irrigation practices represents a key strategy to cope with climate change and aims at supporting sustainable agricultural development. We compute ex ante the additional irrigation required such to compensate the production losses due to climate change and recover the output of the “no climate change” scenario. This information is combined with country specific unitary costs of irrigation projects from FAO to estimate the required amount of investments. Such an additional flow of capital for irrigation in the agricultural sectors is subtracted to the rest of the economic system. This approach allows highlighting the inherent tradeoff within adaptation plans: allocating more investments to agriculture deteriorates the capital stock available for developing the rest of the economic system.

The outcome of increased irrigation in the country targets is heterogeneous. In most cases, irrigation provides higher benefits than costs. This is explained by the higher marginal productivity of capital for irrigation than in other productive sectors, reflected by the large increase in crop yields when cropland is equipped with irrigation systems. Nevertheless, in Mozambique and rest of South Central Africa, the most vulnerable countries to climate change, extending irrigation is not sufficient to bring back production to the reference scenario levels. This lack of response can be explained by the low degree of internationalization of the agricultural sectors that limits the expansion of exports in spite of higher productivity.

P-3320-12

The contribution of fruits and vegetables production to poverty alleviation, nutrition and environment in Africa

D. Feliciano (1)

(1) Institute of Biological and Environmental Sciences, School of Biological Sciences, Aberdeen, United Kingdom

Over the last 20 years, the demand for fresh fruits and vegetables, both in the global and in the local market, has significantly increased. According to Mal et al. (n.d.), it is only in recent years that there is an increasing awareness of the potential of native tropical fruit species as sources of diaria, vitamins, minerals, and energy. Rising incomes and growing consumer interest in product variety, freshness, convenience and year round availability are among the main reasons for this increasing demand (Diop & Jaffee, 2002; Giul et al. 2005). Moreover, the consumption of fruits and vegetables increase when global domestic product per capita goes up, but caution is that this is not a fully linear relation as the overall percentage of the food budget allocated to fruits and vegetables is very low. Fruits and vegetables are rich sources of micronutrients, needed by children for optimal growth and development (WHO/FAO, 2004). Energy, protein, vitamins (A, C, D, and B-complex), and minerals (iron, zinc, iodine) are required for the growth of muscle tissue and bones, brain development, and bodily functions such as the immune
system or co-factors for enzymes. WHO (2009) estimates that 250 million preschool children are vitamin A deficient and as a consequence between 250 000 to 500 000 become blind every year. Most national and international dietary guidelines are in agreement that consumption of fresh fruits and vegetables is a healthy food choice and general needs to be increased. The World Health Organisation recommends a minimum daily intake of 400 g of fruit and vegetables especially for children, and many countries have programmes to promote consumption (FAO/WHO, 2004). Several initiatives have recognised the importance of the consumption of fruits and vegetables to deal with micronutrient deficiencies. One of these is the Global Fruit and Vegetable Initiative for Health and the Environment (PROFAV/PROFILE), launched by FAO and WHO in 2003. This was followed by the elaboration framework for action in 2004 which objective was to guide the development of cost-effective interventions to increase the consumption of fruits and vegetables for health at national or sub-national level (FAO/WHO, 2004). In addition, regional workshops have been held between 2004 and 2014 promoting the consumption of fruits and vegetables, within healthy diets and lifestyles, in the different continents. In 2007, the World Vegetable Centre (AVRDC) submitted a pre-proposal on High-Value Crops: Fruits and Vegetables to the Consultative Group on International Agricultural Research (CGIAR). The objective of this proposal was to broaden the idea of helping the poor to take advantage of the economic and nutritional value of high-value fruits and vegetables in the generation of income and enhance food security and health, taking into account environmental sustainability. However, this proposal did not go ahead.

This papers reviews the literature and analyse FAOSTAT database to investigate how the production of fruits and vegetables contribute to:
1. Poverty alleviation;
2. Improved nutrition and health;
3. Improved natural environment and ecosystem services.

The focus of the paper is Africa. Food consumption patterns have been progressively analysed in developing countries over the past 30 years. However, food production and consumption patterns remain poorly understood in Africa, particularly for fruits and vegetables.

Using phosphorites mine wastes may improve soil fertility and crop production in Togo and in the West African region for food security in a context of climate change

K. Gnand (1)
(1) University of Lome, Dpt of Geology, Lome, France

Phosphorites are been mined in the areas of Hahotee-Kpogamé (Southern Togo) in the Tertiary coastal basin since 1960. The exploited raw phosphorite is naturally enriched with trace metals (Cd, Pb, Cr, Cu, Ni, V, Zn, Ba, Sr, F, U) and rare earths. Phosphorites are transported to the factory of Kpémé close to the beach where they are further treated using sieving and hydrocyclone separation techniques. It results from this process coarser waste and muddy fine grained clayey phosphorites tailings. The solid waste is disposed at sea, on the beach and the muddy waste fraction is landfilled in the hinterland of the sea. Each day, 2.9 million of tons of mining waste are dumped annually into the coastal waters of Togo and causes transboundary marine pollution between Togo, Benin and Nigeria, coastal habitat degradation and the reduction of fish stock.

The phosphorite factory of Kpémé Togo has 5 chains for the treatment of raw phosphorite to commercial pure phosphorite. Each chain produces 1600 tons of muddy phosphorite waste per day. Chemical analysis showed that phosphorites waste contain up to 18 % P2O5, clay minerals and numerous nutritive elements such as Co, Cu, Ni, Cr, Fe, Zn, Mo, Se. and can be used for soil fertilization and crops productivity according laboratory and field experiment. Coagulation and flocculation methods in big decantation basins or dewatering in hydrocyclones are necessary to recover high amounts of solid waste that can be treated and use directly for soil fertilization in Togo and other countries in the West African region for food security in a context of climate change.

Marriage of traditional knowledge and modern science to build the resilience of food security systems in Pacific Island Countries

V. Iese (1); J. Maake (1); M. Wairiu (1); M. Nand (1); E. Holland (1)
(1) The University of the South Pacific, Pacific Centre for Environment and Sustainable Development, Suva, Fiji

Pacific Island Countries prioritized increase agricultural production as a way for sustainable development. Agricultural products can also contribute to energy security as they are developed in developing countries in the world. However, the question remains as to how we can increase agricultural productivity against increasing pressures and uncertainties and with limited information on soil, climate and crops or how to optimize crop productivity and get the best outcomes from our crop management practices and limited arable land areas. Research conducted on both high islands and atolls reveal different level of vulnerabilities including types of crops they cultivate and methods and technologies used. Understanding the vulnerability of the food security systems at the community level is very important in order to strategically plan for resilience. Farmers in studied countries in the Pacific apply both traditional practices and modern innovations to improve their resilience. Employing the holistic approach including climate and weather information (current and future), soil information (physical and chemical), crop or variety suitability and optimized integrated crop management (traditional and modern practices) to improve crop productivity is the way forward for a resilience food security system.

Agriculture is neither the culprit, nor the solution, to climate change

R. Kröbel (1); H. Janzen (1)
(1) Lethbridge Research Center, Science and Technology Branch, Agriculture and Agri-Food Canada, Lethbridge, Alberta, Canada

It may be obvious, but agriculture’s primary function is to produce food. It is in the nature of agricultural systems that they do leak greenhouse gases as part of the food production function, and they undoubtedly contribute to climate change. However, any greenhouse gas component that is emitted was prior fixed from the atmosphere and will recycled to and from the atmosphere eventually. Carbon compounds that adds ever more carbon dioxide to the atmosphere for an everlasting effect of climate change. Carbon sequestration is seen as solution to this problem, and one option that has been widely promoted is the increase and (long-term) storage of soil carbon in agricultural systems. Thus (based on the past versus new principle of life cycle analysis approaches), producers can now promote their production as environmentally friendly when they increase the carbon stock in their soils. The problem is that soil carbon cannot increase endlessly, and so this approach benefits producers who switch away from systems with bad environmental performance rather than producers that were environmentally friendly all along. On top of that, soil carbon gains only make up a minor fraction of the total (current and future), so soil information (systems) is still an issue. Therefore, we propose the following concepts to re-assess the role agriculture plays in climate change:

- Producers benefits should be based on the amount of soil carbon stored (and thus also benefit from increasing them), but the emphasis would be on maintaining the soil carbon stock
- Greenhouse gas emissions from agriculture should be charged against the carbon the system fixated in total (net primary productivity + soil respiration + solar oxidation), as tremendous amounts of fixed carbon are exported from farms each year to feed the human population

The onus should not be on the farmer to responsibly store the carbon resource they produce, similar to the oil industry that is not responsible to educate the consumer towards responsible consumption and utilization of its
L'eau virtuelle des produits agricoles d'importation : Un moyen de contrecarrer le problème du manque d’eau en Algérie

B. Mouhouche (1)
(1) Ecole Nationale Supérieure Agronomique (ENSA) ex INRA, Génie Rural (Hydraulique Agricole), Alger, Algérie

L'Algérie est classée parmi les 17 pays qui souffrent le plus du manque d'eau à travers le monde.

En effet, avec moins de 30 m³/hab./an d'eau renouvelable, l'Algérie dispose de moins de 30% du seuil théorique de rareté fixé par la Banque Mondiale à 1000 m³/hab./an.

Etant dans l'impossibilité d'étendre sa SAU et/ou d'augmenter les surfaces irriguées, pour combler le déficit alimentaire, l'Algérie a recours à des importations massives de produits alimentaires, particulièrement les céréales et leurs dérivés.

Ajouté à cela les produits agricoles non-alimentaires.

Ces importations, bien qu'elles représentent une hécatombe financière, permettent de produire l'abondance de biomasse produite chaque année sur les terres agricoles soit une solution plus appropriée de stockage de biomasse virtuelle, et de manière plus durable, car elle n'est pas exposée au risque de corrosion, d'insectes, d'altération ou d'incendie.

P-3320-16

Fitting neglected and underutilised crops into climate change adaptation strategies

T. Mabhaudhi (1); A. Modi, (1)
(1) University of KwaZulu-Natal, Crop Science, School of Agricultural and Environmental Sciences, Pietermaritzburg, South Africa

Agriculture is the predominant activity sustaining livelihoods in sub-Saharan Africa with about 70% of the region’s population relying on agriculture for their sustenance. In this region, about 95% of agriculture is primarily rainfed and relies mainly on a few starchy cereal and root and tuber crops for dietary provision. Climate change and variability are expected to result in increased variability of rainfall as well as severity and intensity of extremes such as drought and floods. This places pressure on food and nutritional security within a region that is already behind with achieving Millennium Development Goal – 1. Consequently, there has now been mounting pressure on the region to develop climate change adaptation strategies at various levels. These strategies, which include climate smart agriculture, are mainly focusing on the major crops. There is a need to include alternative crops – the neglected and underutilised crop species (NUCS). These are crops that have historically formed the rich tapestry of agro-biodiversity that exists within the region. By definition, NUCS are crops that have not been previously classified as major crops, have previously been under-researched, currently occupy low levels of utilisation and are mainly confined to smallholder farming areas. Historically, NUCS have played an important role in contributing to household food and nutrition security through providing healthy alternatives when the major crops failed or during periods in-between subsequent harvests. The promotion of a few major crops during the Green Revolution subsequently led to their relegation to their current although they still offer much potential. Across much of SSA, water availability remains the major limiting factor to crop production, threatening food security of vulnerable groups. It is also expected that water would be the primary medium through which impacts of climate change and variability would be experienced. Most NUCS are believed to be resilient and adapted to a range of climates, low input agriculture and low levels of utilisation. They are therefore an important component in developing climate change adaptation strategies. These strategies, which include climate smart agriculture, are mainly focusing on the major crops. There is a need to include alternative crops – the neglected and underutilised crop species (NUCS). These are crops that have historically formed the rich tapestry of agro-biodiversity that exists within the region. By definition, NUCS are crops that have not been previously classified as major crops, have previously been under-researched, currently occupy low levels of utilisation and are mainly confined to smallholder farming areas. Historically, NUCS have played an important role in contributing to household food and nutrition security through providing healthy alternatives when the major crops failed or during periods in-between subsequent harvests. The promotion of a few major crops during the Green Revolution subsequently led to their relegation to their current although they still offer much potential. Across much of SSA, water availability remains the major limiting factor to crop production, threatening food security of vulnerable groups. It is also expected that water would be the primary medium through which impacts of climate change and variability would be experienced. Most NUCS are believed to be resilient and adapted to a range of climates, low input agriculture and low levels of utilisation. They are therefore an important component in developing climate change adaptation strategies.

P-3320-17

L’eau virtuelle des produits agricoles d’importation : Un moyen de contrecarrer le problème du manque d’eau en Algérie

B. Mouhouche (1)
(1) Ecole Nationale Supérieure Agronomique (ENSA) ex INRA, Génie Rural (Hydraulique Agricole), Alger, Algérie

L’Algérie est classée parmi les 17 pays qui souffrent le plus du manque d’eau à travers le monde.

En effet, avec moins de 30 m³/hab./an d’eau renouvelable, l’Algérie dispose de moins de 30% du seuil théorique de rareté fixé par la Banque Mondiale à 1000 m³/hab./an.

Etant dans l'impossibilité d’étendre sa SAU et/ou d’augmenter les surfaces irriguées, pour combler le déficit alimentaire, l’Algérie a recours à des importations massives de produits alimentaires, particulièrement les céréales et leurs dérivés.

Ajouté à cela les produits agricoles non-alimentaires.

Ces importations, bien qu’elles représentent une hécatombe financière, permettent de produire l’abondance de biomasse produite chaque année sur les terres agricoles soit une solution plus appropriée de stockage de biomasse virtuelle, et de manière plus durable, car elle n’est pas exposée au risque de corrosion, d’insectes, d’altération ou d’incendie.
Traditional farming practices and water management for Climate change adaptation in Sri Lanka

RU. Piyadasa (1)
(1) University of Colombo Sri Lanka, Geography Department, Colombo, Sri Lanka

Sri Lanka is one of the few countries in the world that has had a thriving and vibrant irrigation based civilization for over two thousand years. The cascade system, they used for traditional organic cultivation of paddy, harmonized environment and development in an environmentally sound and sustainable manner. Sri Lankan history is deeply connected with its hydraulic civilization and its erroneously named as a community based cascade ecosystem irrigation. In Sri Lanka water is collected using man-made interconnected cascade tanks ecosystems in dry areas mainly for paddy cultivation. These tanks comprise of various components of ecological importance. Tank cascade ecosystems were constructed mainly in two ways, either by impounding a river or by diverting the river through canals. In early days villages were built around tanks to allow easy access to water for agricultural purposes. Tanks were also important for cultural, spiritual and religious reasons, as water is a symbol of life and purity. While the challenges are daunting, they also provide opportunities for local communities, business and government to innovate for the benefit of communities, economies and the global environment. The cascade ecosystems, throughout the Sri Lanka in particular, are under unprecedented pressure, threatening prospects for sustainable development. Tanks were constructed mainly in two ways, either by impounding a river or by diverting the river through canals. In early days villages were built around tanks to allow easy access to water for agricultural purposes. Tanks were also important for cultural, spiritual and religious reasons, as water is a symbol of life and purity. Cascade ecosystems were originated within the community and practiced over many generations. Presently managed by community Farmer Organizations and government. The all the cascade ecosystem based irrigation systems were operated and managed by the community. Responsibility rests with the chief of the village community based organization. Ecosystem that helped the community in passing through the difficult times during the droughts; a system that nurtured the development of drought insurance through animal husbandry and fragmented land ownership; and that provided opportunities for inland fishing and human and animal nutrition. The ecosystem operate with the collection of rainwater harvesting technology; moisture and groundwater maintaining technology; a soil erosion and silviation control technology; a technology that ensured the maintenance of ecological balance; a technology that promoted social cohesion and need for community leadership; a system that accommodated spiritual development which promoted egalitarian attitudes. On the basis of the above appearance, the cascading systems would have operated as an ideal community based adaptation to climate change.
increasing incidences of periodical droughts emanating from climate change. This is causing the entire continent, including South Africa, which is the region’s largest producer of the crop to increasingly depend on imported wheat. There is, therefore, a need to continuously search for new cultivars. The Atlantic Ocean has a large export market, even for non-GMO crops. The land use polices have a strong influence on farmers’ crop choice through designated land uses, subsidies and seedling supply. Home gardens, which are excluded from land use policies, were an understudied resource for diversity. In particular, food secure households with home gardens were more benign to experiment. Lastly, as no mitigation mechanisms in place, farmers benefited neither from the carbon sink potential of their rice paddies nor from the carbon gas emission-reducing agricultural practices.

The study concludes that realizing the full potential of Climate-smart Agriculture (CSA) requires a careful and well-adapted portfolio of context-specific technologies and improved local practices, (2) that farmers and local land use planners are able to estimate costs-and-benefits of business-as-usual versus adaptation and mitigation options, and (3) an enabling policy environment streamlined towards CSA.

P-3320-23
Clam farming in the Lagoon of Venice. How to adapt to local and global changes?
C. Solidoro (1) ; G. Cossarini, (1) ; F. Giorgetti (2) ; MC. Donata (1)
(1) Istituto nazionale di Oceanografia e di Geofisica Sperimentale OGS, oceanography, Trieste, Italy; (2) International Centre for Theoretical Physics (ICTP), Earth system physics (esp) section, Trieste, Italy

Culture based fisheries and aquaculture deeply rely on the coastal and marine environmental conditions and can be highly vulnerable to anthropogenic pressures and to climatic changes. Adaptation and mitigation measures to local and global changes need to be supported by information and assessments...

With this aim, a downscaling experiment linking a regional atmospheric model to local ecosystem and a target species population dynamic model was conducted to evaluate the effects of IPCC climate change scenarios on a temperate coastal lagoon ecosystem, the lagoon of Venice, along with goods and services provided by this ecosystem. Our results indicate that the changes in water temperature and reduction in plankton productivity caused by the modification of seasonal precipitation patterns will affect habitat suitability for clam growth and aquaculture. Our simulations show that aquaculture will suffer under projected future climate conditions and indicate that implementation of site- and condition-specific adaptive aquaculture management policies can mitigate the adverse effects of GC. This conclusion can be generalised to other temperate coastal systems and might be of particular importance in ecological-social-economic systems where clam farming is crucial for a self-sustaining economy.

P-3320-24
Climate-smart Agriculture put into Practice: The case of Rice Production in Southeast Asia
R. Wassmann (1) ; R. Reinke (1) ; BO. Sander (1) ; P. Picarelli, (1)
(1) International Rice Research Institute, Los Banos, Philippines

The concept of Climate-smart Agriculture (CSA) encompasses both mitigation and adaptation practices that are fused into one comprehensive approach for devising sustainable farming systems. Rice production is an ideal model crop to illustrate the coherence of these principles as the rice cultivation chain is characterized by a wealth of knowledge and previously developed farming practices for coping with adverse climatic conditions (to be tapped for adaptation) and for increasing resource use efficiencies (to be tapped for mitigation). Plan for the Future (P4F) rice breeding program has a proven track record to increase resilience of the rice crop against drought, submergence, salinity and heat stress. New biotechnology tools allow expeditious and precise changes in the rice genome that increase their performance under climatic stresses.

Rice is a major source of the Greenhouse Gases (GHGs) methane and – to a lesser extent – methane. Given that high rice yields are imperative to food security, the key to reducing GHGs is increasing resource-use efficiencies, namely of water and fertilizer. Methane is produced by the microbial community in flooded soils. In turn, water saving techniques such as Alternate Wetting and Drying (AWD) can be deployed to effectively reduce methane emissions while
Potential Contribution of Supplemental Irrigation as a key Strategy of Local Adaptation to Climate Change in small holder farming in the Sudan Savanna zone of West Africa

OBJECTIVES

Objective: document lessons learned and identify opportunities and barriers to scaling up health adaptation to climate change in small holder farming in the Sudan Savanna zone of West Africa.

Methods: a qualitative approach was used to evaluate the impact of supplemental irrigation on rice yield and water productivity. Field experiments were conducted during the 2013 and 2014 growing seasons. The experiments were conducted on a local variety of rice (Kangera) under both rainfed and irrigated conditions.

Results: the results showed that supplemental irrigation significantly increased rice yield and water productivity. The highest yield was obtained under supplemental irrigation, with yields of 8.5 and 6.0 t/ha under early and medium dates of sowing, respectively. Under late dates of sowing, the yield was lower, with a yield of 3.5 t/ha. The water productivity was highest under supplemental irrigation, with values of 11.71 kg/ha/mm, 7.16 kg/ha/mm, and 5.40 kg/ha/mm under early, medium, and late dates of sowing, respectively.

Discussion: supplemental irrigation is a key strategy to help farmers to adapt to climate change, particularly in regions with water limitations. The results of this study highlight the potential of supplemental irrigation to increase rice yield and water productivity in the Sudan Savanna zone of West Africa.

Conclusion: the results of this study demonstrate the potential of supplemental irrigation as a strategy to improve rice yield and water productivity in the Sudan Savanna zone of West Africa. Further research is needed to evaluate the long-term effects of supplemental irrigation on rice yield and water productivity in this region.
as malnutrition, malaria, dengue fever, diarrhea and deaths due to coastal floods. Although ‘autonomous adaptation,’ i.e., optimum temperature becomes higher along with the warming climate without specific adaptation policy would occur, this ubiquitous impact all over the globe would require us to take actions for mitigation and adaptation.

Conclusion: Heat-related excess mortality would affect both developing and developed countries, and shows a good example of the necessity of cooperation all over the world.

Acknowledgements: This study was supported by the Environment Research and Technology Development Fund (S8 & S10) of the Ministry of the Environment, Japan, and the Global Research Laboratory (grant K2104000001-10A0500-00710) through the National Research Foundation of Korea (NRF), funded by the Ministry of Education, Science, and Technology, Korea.

O-3321-03
Global Risk Assessment of the Effect of Climate Change on Selected Causes of Death in 2030s and 2050s
S. Kovats (1) ; S. Hales (2) ; D. Campbell-Lendrum (3) ; J. Rocklov, (4) ; Y. Honda (5) ; S. Lloyd, (6)
(1) London School of Hygiene and Tropical Medicine, Social and Environmental Health Research, London, United Kingdom; (2) University of Otago, Wellington, New Zealand; (3) World Health Organization, Public Health, Environmental and Social Determinants of Health, Geneva, Switzerland; (4) Umeå University, Umeå centre for global health research, Umeå, Sweden; (5) University of Tsukuba, Faculty of Health and Sport Sciences, Tsukuba, Japan; (6) London School of Hygiene and Tropical Medicine, London, United Kingdom

Climate change is likely to affect human health with important differences by world region. As climate change is likely to affect proximal and distal (upstream) risk factors for a wide range of health outcomes, the quantification of these risks and burdens is complex, and few global models are available. We will report the findings of a global assessment of the impact of climate change on selected mortality outcomes undertaken for the World Health Organization.

Future cause-specific mortality in 2030 and 2050 (in the absence of climate change) was estimated using regression methods for three development futures: base case, high growth, and no-growth scenarios. Global climate–health models were developed for 12 outcomes known to be sensitive to climate change: heat-related mortality in elderly people, mortality associated with coastal flooding, mortality associated with diarrhoeal disease, heat-related deaths in children under 15 years, population at risk and mortality, dengue population at risk and mortality, undernutrition (stunting) and associated mortality, the number of people with climate change associated by a medium–high emissions scenario (A1b) run through three climate models. The counterfactual was a future world with population growth and economic development but with baseline (1961–1990) climate. The annual burden of mortality due to climate change was estimated for world regions. For most pathways considered, the results reflect both positive and negative impacts on health.

Compared with a future without climate change, the following additional deaths are projected for the year 2030: 38 000 due to heat exposure in elderly people, 48 000 due to diarrhoeal diseases, 45 000 due to childhood undernutrition. WHO projects a dramatic decline in child mortality, and this is reflected in declining climate change impacts from child malnutrition and diarrhoeal disease between 2030 and 2050. On the other hand, by 2050, deaths related to heat exposure (less than 100 000 per year) are projected to increase. Impacts are greatest under a low economic growth scenario because of high heat and limited food and water in low- and middle-income countries. By 2050, impacts of climate change on mortality are projected to be greatest in south Asia. These results indicate that climate change will have a significant impact on child health by the 2050s.

A main limitation of this assessment is the inability of current models to account for major pathways of potential health impact, such as the effects of economic damage, major heatwave events, river flooding and water scarcity. The assessment also did not consider the impacts of climate change on human security. Current models can capture only a subset of potential causal pathways, and none account for the effects of major discontinuities in climatic, social or ecological conditions.

Global climate change is projected to have substantial adverse impacts on future mortality, even considering only a subset of the expected health effects, and under optimistic scenarios of future socioeconomic development and adaptation. This indicates that avoiding climate-sensitive health risks is an additional reason to mitigate climate change. The results indicate that significant impacts of climate change cannot be avoided, and supports the case for strengthening both current and future health policies.

O-3321-04
Managing climate-sensitive health risks in vulnerable Pacific Island communities with minimal adaptive capacity: Lessons from Rabi Island
H. Bambrick (1) ; S. Moncada (2)
(1) University of Western Sydney, School of medicine, Sydney, Australia; (2) University of Malta, Institute for European studies, Msida, Malta

In coming years, the Pacific is expected to experience increasing climate extremes as periods of drought and heavy rainfall, cyclones and heat become more frequent and intense, oceans become warmer and more acidic, and sea-level rise affects arsine water causing flooding. Pacific Island communities are especially susceptible to the health impact of climate change due to their isolation, limited land area, low lying topography, and generally high levels of inherent vulnerability, together with poverty and widespread reliance on subsistence farming. The poorest communities especially are inadequately resourced to manage current climate and health risks, and have even less capacity to prepare for and adapt to long-term climatic changes. Despite the acceptance that communities in the Pacific are highly vulnerable, very little is known about how these risks may best be managed with so few resources and the structural disadvantages typical of small island developing states. Existing data in the region relevant to climate and health is sparse, may not be relevant to particular communities, and may miss important local features. This study is an in-depth assessment of vulnerability on Rabi Island. We document current health conditions, especially how they impact on climate-sensitive health risks. We evaluate contemporary coping mechanisms and capacity for adaptation, in order to develop feasible and acceptable strategies in the context of extremely limited resources.

Rabi Island is a small volcanic island in Fiji situated to the east of Vanua Levu, one of Fiji’s two main islands. Rabi is home to around 5000 Banaba Islanders who were brought there from Kiribati 70 years ago, displaced by phosphate mining on their home island. The islanders have maintained their Banaba culture and language and have dual Kiribati-Fijian citizenship. In the mid-19th century, Rabi is typical of Pacific vulnerability to climate change – underlying poor health, poverty and exposure to extreme events such as cyclones – with the added complexity of being an ethnic minority population that is culturally isolated from the rest of the country. Income is very low, houses are crowded, and islanders rely on fishing and subsistence farming. Aside from coconuts that are collected for processing, there is a single cash-crop, kava, that generates most of the income on the island. Vector-borne disease, food- and water-borne and other communicable diseases, ciguatera (fish poisoning), malnutrition and direct physical trauma during extreme events are the leading health risks. We present our findings from our vulnerability assessment using data from a detailed random household survey (156 item questionnaire, 200 households, yielding data on 1500 individuals) and from focus groups of women and men in each village using Participatory Rural Appraisal
Impacts of Climate Change on Vector Borne Diseases in the Mediterranean Basin - Implications for Preparedness and Adaptation Policy

S. Paz (1) ; M. Negev (2) ; M. Green (2)
(1) University of Haifa, Geography and Environmental Studies, Haifa, Israel; (2) University of Haifa, School of public health, Haifa, Israel

The Mediterranean region is vulnerable to climatic changes. A warming trend exists with an increase in warm days and nights, longer and warmer summers, and an increase in the frequency and the severity of heat waves and a reduction in rainfall amounts. Therefore, it is expected that vector-borne diseases (VBD) will become more prevalent in this area. Climate change, both directly and indirectly, will increase the risk of diseases such as malaria, dengue fever, and West Nile virus. The Mediterranean region is particularly vulnerable to these changes because of the close proximity to the Middle East and Africa, where climate change is already affecting disease transmission.

The Mediterranean region has a high concentration of elderly populations, which are more susceptible to the effects of climate change. The region also has a high concentration of people with low socioeconomic status, who are more vulnerable to the impacts of climate change.

Adaptation to potential shifts in malaria breeding sites: larvicide application in Sub-Saharan Africa, guided by risk maps based on remote sensing

I. Traore (1) ; A. Sié (2) ; V. Machault (3) ; C. Vignolles (4) ; R. Sauerborn (5) ; P. Dambach (5) ; N. Becker (6)
(1) Centre de Recherche en Santé de Nouna, Service Formation Recherche et Communication, Nouna, Region Boucle du Mouhoun, Burkina Faso; (2) Centre de Recherche en Santé de Nouna, Direction, Nouna, Burkina Faso; (3) Laboratoire d’Aéologie, Toulouse, France; (4) CNES, Toulouse, France; (5) Heidelberg University, Institute of public health, Heidelberg, Germany; (6) German Mosquito Control Association, Heidelberg, Germany

Climate change is likely to lead to shifting patterns of temporal and spatial distribution of many vector borne diseases, such as malaria. Firstly, this could lead to new areas becoming suitable for malaria transmission, particularly in higher altitudes and latitudes. Secondly, we could observe epidemic patterns of malaria transmission and thirdly within the area of current endemicity, we could see e.g. a prolongation of the transmission period and a change in the productivity of breeding sites.

In Sub-Saharan Africa, significant progress has been made in providing access to bed-nets, immunized with insecticides and in offering subsidized, but still expensive malaria treatment. Both control measures are likely to have less than optimal effectiveness: Health care seeking drops in offering subsidized treatment; and thirdly in offering subsidized treatment; and thirdly within the area of current endemicity, we could see e.g. a prolongation of the transmission period and a change in the productivity of breeding sites.

We conducted a series of trials to test the effectiveness of larvicides in different areas. The results showed that larvicides are a cost-effective measure for malaria control, particularly in high and middle-income countries in larval control programs without showing any adverse human or biodiversity side effects. In Africa, larviciding is largely absent in malaria control. This is generally attributed to the perceived high costs of biological larvicides and the high cost of treating all breeding sites around human settlements every two weeks during the rainy season.

We developed and validated a technique using SPOT-5 satellite images to predict which breeding sites would carry Anopheles larvae and at which larval productivity. The remote sensing pixel based approach was compared with field entomological and ecological data until a high degree of agreement was achieved. We used this novel technique to test two separate hypothesis that (i) applying larvicides is a cost-effective measure for malaria control compared to currently applied control measures; and (ii) that it makes cost-effectiveness sense to apply the larvicides only to the breeding sites with the highest larval productivity.

A vulnerability/resilience framework approach

L.P. Briguglio (1) ; S. Moncada (2)
(1) University of Malta, Islands and Small States Institute, Msida, Malta; (2) University of Malta, Institute for european studies, Msida, Malta

The presentation will draw on the literature on the health impacts of climate change, and will re-position the arguments in a vulnerability/resilience framework. It will be argued that many communities are located in territories that are inherently prone to being negatively affected by global warming in terms of health and this will have major negative impacts on human capital in these territories. This will be the vulnerability side of the argument. The resilience side of the argument will relate to what can be done, policy-wise, to strengthen the ability of communities to evade health problems and set up systems and even possibly improve their health condition, in the face of global warming. These could include adaptation and mitigation measures. The outcome of inherent vulnerability and policy-induced resilience could result in a net strengthening of human capital.

A-3321-05

A vulnerability/resilience framework approach

L.P. Briguglio (1) ; S. Moncada (2)
(1) University of Malta, Islands and Small States Institute, Msida, Malta; (2) University of Malta, Institute for european studies, Msida, Malta

The presentation will draw on the literature on the health impacts of climate change, and will re-position the arguments in a vulnerability/resilience framework. It will be argued that many communities are located in territories that are inherently prone to being negatively affected by global warming in terms of health and this will have major negative impacts on human capital in these territories. This will be the vulnerability side of the argument. The resilience side of the argument will relate to what can be done, policy-wise, to strengthen the ability of communities to evade health problems and set up systems and even possibly improve their health condition, in the face of global warming. These could include adaptation and mitigation measures. The outcome of inherent vulnerability and policy-induced resilience could result in a net strengthening of human capital.

A-3321-06

A vulnerability/resilience framework approach

L.P. Briguglio (1) ; S. Moncada (2)
(1) University of Malta, Islands and Small States Institute, Msida, Malta; (2) University of Malta, Institute for european studies, Msida, Malta

The presentation will draw on the literature on the health impacts of climate change, and will re-position the arguments in a vulnerability/resilience framework. It will be argued that many communities are located in territories that are inherently prone to being negatively affected by global warming in terms of health and this will have major negative impacts on human capital in these territories. This will be the vulnerability side of the argument. The resilience side of the argument will relate to what can be done, policy-wise, to strengthen the ability of communities to evade health problems and set up systems and even possibly improve their health condition, in the face of global warming. These could include adaptation and mitigation measures. The outcome of inherent vulnerability and policy-induced resilience could result in a net strengthening of human capital.

A-3321-07

Adaptation to potential shifts in malaria breeding sites: larvicide application in Sub-Saharan Africa, guided by risk maps based on remote sensing

I. Traore (1) ; A. Sié (2) ; V. Machault (3) ; C. Vignolles (4) ; R. Sauerborn (5) ; P. Dambach (5) ; N. Becker (6)
(1) Centre de Recherche en Santé de Nouna, Service Formation Recherche et Communication, Nouna, Region Boucle du Mouhoun, Burkina Faso; (2) Centre de Recherche en Santé de Nouna, Direction, Nouna, Burkina Faso; (3) Laboratoire d’Aéologie, Toulouse, France; (4) CNES, Toulouse, France; (5) Heidelberg University, Institute of public health, Heidelberg, Germany; (6) German Mosquito Control Association, Heidelberg, Germany

Climate change is likely to lead to shifting patterns of temporal and spatial distribution of many vector borne diseases, such as malaria. Firstly, this could lead to new areas becoming suitable for malaria transmission, particularly in higher altitudes and latitudes. Secondly, we could observe epidemic patterns of malaria transmission and thirdly within the area of current endemicity, we could see e.g. a prolongation of the transmission period and a change in the productivity of breeding sites.

In Sub-Saharan Africa, significant progress has been made in providing access to bed-nets, immunized with insecticides and in offering subsidized, but still expensive malaria treatment. Both control measures are likely to have less than optimal effectiveness: Health care seeking drops in offering subsidized treatment; and thirdly in offering subsidized treatment; and thirdly within the area of current endemicity, we could see e.g. a prolongation of the transmission period and a change in the productivity of breeding sites.

We conducted a series of trials to test the effectiveness of larvicides in different areas. The results showed that larvicides are a cost-effective measure for malaria control, particularly in high and middle-income countries in larval control programs without showing any adverse human or biodiversity side effects. In Africa, larviciding is largely absent in malaria control. This is generally attributed to the perceived high costs of biological larvicides and the high cost of treating all breeding sites around human settlements every two weeks during the rainy season.

We developed and validated a technique using SPOT-5 satellite images to predict which breeding sites would carry Anopheles larvae and at which larval productivity. The remote sensing pixel based approach was compared with field entomological and ecological data until a high degree of agreement was achieved. We used this novel technique to test two separate hypothesis that (i) applying larvicides is a cost-effective measure for malaria control compared to currently applied control measures; and (ii) that it makes cost-effectiveness sense to apply the larvicides only to the breeding sites with the highest larval productivity.

A vulnerability/resilience framework approach

L.P. Briguglio (1) ; S. Moncada (2)
(1) University of Malta, Islands and Small States Institute, Msida, Malta; (2) University of Malta, Institute for european studies, Msida, Malta

The presentation will draw on the literature on the health impacts of climate change, and will re-position the arguments in a vulnerability/resilience framework. It will be argued that many communities are located in territories that are inherently prone to being negatively affected by global warming in terms of health and this will have major negative impacts on human capital in these territories. This will be the vulnerability side of the argument. The resilience side of the argument will relate to what can be done, policy-wise, to strengthen the ability of communities to evade health problems and set up systems and even possibly improve their health condition, in the face of global warming. These could include adaptation and mitigation measures. The outcome of inherent vulnerability and policy-induced resilience could result in a net strengthening of human capital.
kind. All study arms receive the current national routine malaria control measures.

The results show that larvicidal treatment is highly effective both in larvae removal for 2 weeks under field conditions and in increasing adult mosquito abundance in reference villages. First cost data indicate that the costs of locally adapted larviciding compare favorably to those of impregnated bed nets and that the targeted 50% larvicidal intervention costs about 35% less cost. Analysis of data on the effect of malaria transmission to children under five years is under way.

**O-3321-08**

The Effect of Training on Health: Biogas Development Interventions to Enhance Health Resilience to Climate Change in Informal Urban Settlements in Ethiopia

S. Moncada (1); H. Bambrick (2)

(1) University of Malta, Institute for European studies, Msida, Malta; (2) University of Western Sydney, School of Medicine, Penrith, Australia

This paper measures the impact of community-level Overseas Development Assistance (ODA) on public health, specifically focusing on the provision of training. It is often the case that biogas programmes do not include any training component accompanying the intervention. The study is believed to be either too expensive or simply overlooked. However, improved sanitation facilities do not automatically translate into better health standards. The context of this research is an informal urban settlement in Ethiopia, characterised by extreme poverty, poor sanitation and exposure to climate-sensitive risks, where a biogas sanitation project funded by ODA was implemented in 2013. The development intervention included environmental and sanitation training, provided to 45 heads of the 200 beneficiary households of the project. Quasi-experimental techniques with propensity score matching methods are applied using two waves of panel data generated from a dedicated survey conducted among all the households.

The study finds that training, provided within the biogas and sanitation development intervention, had positive effects on a number of health indicators including self-assessed health and lower use of contaminated water from the river. Although training beneficiaries carry additional costs during implementation, the benefits are significant, suggesting long-term behavioural changes. Participants who live closer to the biogas facilities enjoyed further health benefits, reinforcing arguments for the scaling-up of biogas development and sanitation interventions inclusive of training in informal urban settlements to enhance health resilience to climate change.

**P-3321-02**

Climate Change and the use of Serious Games: responses for Neglected Tropical Diseases in Southwestern Amazonia

M. Cesarro (1); L. Saturnino (2); M. Masoodian (3); R.R. Cesarro (4)

(1) Academia Magdala, Franca, São Paulo, Brazil; (2) Trinity College Dublin – University of Dublin, School of computer science – o’ reilly institute, Dublin, Ireland; (3) University of Waikato, School of computer science, Hamilton, New Zealand; (4) University of Franca, Medical school, Franca, Brazil

In the Brazilian Amazon Region, Land Use/Cover Change – the main contributor to the national emissions of Green House Gases – equals to deforestation through anthropogenic forest-fires. The associated biodiversity loss affects the spread of vector-borne Neglected Tropical Diseases (NTDs), due to the susceptibility of infections to environmental degradation, which in turn disrupt natural cycles. Balanced ecosystems, where those natural cycles occur, act as buffer zones between zoonosis and susceptible human populations. The Brazilian Ministry of Health, known as “Infectious Diseases Regulation”. This paper addresses the potential benefits of using a “serious game” as part of community-based healthcare practices, to educate local citizens about ways to control and reduce the spread of NTDs in remote regions, especially in the tri-national South-western Amazonia. American Cutaneous Leishmaniasis represents an ideal challenge for the application of complex ludic educational tools, because its complex and poorly understood transmission cycle involves humans, their dogs, insect vectors, sylvatic reservoirs and other domestic animals (chicken, pig, etc.) that act as intermediate and sylvatic reservoirs to the peri-domestic. The existing efforts to control American Cutaneous Leishmaniasis’ transmission have relied, so far, on the development of insecticides. To broaden the approach, this paper focuses on American Cutaneous Leishmaniasis, and aims to involve lay citizens and primary health-care personnel in collective tasks around their local community and individual households, where they are responsible for the health maintenance and to protect people and dogs against vector biting. This game can be easily extended to Visceral Leishmaniasis, as well as to other vector-borne endemic diseases, such as Dengue Fever, Chikungunya and Malaria. The design process of the game architecture of the so-called Dr Ludens’ LSG (Leishmaniasis Serious Game), expected to be the first game of a Dr Ludens’ series. It focuses on American Cutaneous Leishmaniasis, and aims to involve lay citizens and primary health-care personnel in collective tasks around their local community and individual households, where they are responsible for the health maintenance and to protect people and dogs against vector biting. This game can be easily extended to Visceral Leishmaniasis, as well as to other vector-borne endemic diseases, such as Dengue Fever, Chikungunya and Malaria. The design process of the game architecture of the so-called Dr Ludens’ LSG, developed by a multidisciplinary team of computer and epidemiological scientists, is described, as well as a recent evaluation by a group of leishmaniases’ experts. These researchers have identified several positive aspects of our prototype, as well as suggested a number of improvements to make its future deployment more effective and widespread. The implementation of these suggested improvements is intended to be done before
releasing Dr Ludens’ LSC to selected local people at the study region A longitudinal study of its use and potential educational benefits towards the Knowledge, Attitudes and Practices of these selected users, in regards to their diseases’ preventative measures, is also envisaged. With this increased internet connectivity to each remote regions, there is vast potential for application of the new generation of highly connected interactive games to disease prevention and control, by means of education and awareness raising through mobile phones. When people see, clearly, interconnections between Climate Change and their own lives, including their increasing risk of contracting infectious diseases, they become more likely to adopt a low carbon way of life.

P-3321-03
Impact of Climate Change on Influenza Mortality in US: A Generalized Additive Model Analysis
S. Dasgupta (1); L. Wing, (2)
(1) Fondazione Eni Enrico Matti (FEEM), Venezia, Italy; (2) Boston University, Dept. of earth & environment, Boston, United States of America

Each year approximately 5–20 percent of US residents suffer from influenza and more than 200,000 are hospitalized (CDC, 2014). The effect of annual influenza on the US economy has been costed in terms of lost productivity, the use of health services, and, for influenza-related hospitalizations and days and 31.4 million outpatient visits with direct medical costs estimated at over $10 billion (Molnari, 2007). The influence of weather and climate on influenza transmission and mortality has been studied in a variety of ways and with varying levels of complexity, especially in epidemiology, however, there is little robust evidence. Exposure to extreme temperatures and/or extreme humidity levels increases the risk of mortality mainly through impacts on our cardiovascular and respiratory systems. Epidemiological studies (Barecca and Shimizu, 2012; Deschenes and Bentetti, 2007; Lowens, 2007; and Martens, 1998) state that colder temperatures have greater influence on mortality than warmer temperatures but hot temperatures are more likely to cause inter-temporal distribution of mortality by expediting the time-to-death of those individuals already nearing death. Humidity can also affect human health through a variety of mechanisms. Low humidity levels can lead to dehydration and increase the spread of influenza (Lowen et al., 2007; Shamer and Kohn, 2009; and Xie et al., 2007), while high humidity levels exacerbate the effects of heat stress because humidity impairs the body’s ability to cool itself down. Relative humidity conditions, which are often accompanied by low temperatures, enhance survival times of viral aerosols (Losoli, 1943; Harper, 1961; and Schaffer, 1976). This paper utilizes generalized additive models (GaM) which are semi-parametric and allow for the examination of non-linear relationships between the response and a set of explanatory variables.

Essentially, GAM is a nonparametric extension of generalized linear models (GLM), used often for the case when there is no a priori reason for choosing a particular response function and the response functions need to be generated from the data itself. GAMs (Hastie and Tibshirani, 1986, 1990) are semi-parametric extensions of GLMs; the only underlying assumption made is that the functions are additive and that the components are smooth. A GAM is a GLM, uses a link function g(.) relating the mean μ to the linear predictor Xβ. The general form is; g(μ) = Xβ

Our results provide robust evidence of non-linear impact of both temperature and humidity on influenza mortality rates. The risk of influenza mortality is highest between minimum temperatures of –30°C and –10°C and declines as the minimum temperature goes above 8°C. In the case of maximum temperature, the risk of influenza mortality is highest in the range of –15°C and 5°C, while the effect of minimum specific humidity is highest between 5 g/kg and 20 g/kg. The medical and epidemiological literature suggests that dry conditions result in moisture losses and lead to dehydration and increases spread of influenza by increased viral shedding (Salah et al., 1988; Losoli, 1943; Harper, 1961; and Schaffer, 1976). Results also suggest that influenza mortality is insensitive to high temperature levels. When combined with observed climate for the year 2014, our results indicate that the highest risk of influenza mortality is between –20°C and –10°C and for mean specific humidity, the risk is highest between 7.5 g/kg and 15 g/kg. This range is particularly significant as Lowen et al. (2007) reports that the infection and transmission of influenza virus is highly efficient at relative humidity (RH) of 65 percent – equivalent to specific humidity of 13 g/kg. In conclusion, our findings provide empirical evidence to epidemiological experiments. These results provide comprehensive empirical evidence influential epidemiological works under laboratory condition by Cannell et al. (2008), Lofgren et al.(2007) and Lowen et al. (2007).

P-3321-04
Modelling adaptation in climate change impact assessments of heat-related mortality
S. Gosling (1); D. Hondula (2)
(1) International Society of Biometeorology (ISB), Nottingham, Nottinghamshire, United Kingdom; (2) Arizona State University, Center for policy informatics, school of public affairs, Phoenix, United States of America

The potential for populations to respond to warmer temperatures under climate change scenarios by adaptation means that non-stationary heat–related mortality models should be applied in climate change impact assessments. However, there is no uniformly accepted method for modelling adaptation. Other studies have attempted to consider adaptation response by employing statistical methods, of varying complexity, including regression techniques that control for historical adaptation (Ahrens, 2007). As adaptation can be present vulnerabilities to the future, and the application of ‘analogue’ cities whose present climate best approximates the estimated climate of a target city as expressed by climate model simulations. Even considering the existence of these disparate approaches, there has to date been no comprehensive comparison of them. In turn this has precluded the development of a standard and commonly applicable technique for modelling adaptation in climate change impact assessments. We outline an ongoing study that aims to compare a number of approaches for modelling adaptation by using a consistent set of input data and temperature–mortality models for several cities, with a means to understanding the relative merits of the different approaches. An ambitious goal of our research project is to recommend a standard method that could be adopted by future climate change impact assessments of heat-related mortality and to this end address an important gap in knowledge and techniques on health responses to climate change.

P-3321-05
Whether Changing Environmental Conditions of Living negate the impact of Socio-economic Development on Health Outcomes of Urban Poor?
R. Goyal (1)
(1) Ramana Group, –, Dehradun, Uttarakhand, India

In recent years, climate change has almost becomes synonyms with development of environmental hazards affecting all living being. The adverse affects are particularly large on those segments of populations where current burden of climate-sensitive disease is high. One
such category is urban poor which is characterized by cramped living spaces, lack of sanitation and safe drinking water, poor and unhygienic environmental conditions, poor socio-economic status etc. As a consequence, their major health and morbidity indicators (due to communicable and non-communicable diseases) and mortality rates are higher than other sections of population viz., rural and urban non-poor. It has also been observed that unlike the rural areas, programs to address socio-economic development and healthcare needs in urban poor localities have limited impact on health outcomes. Why? Is it because living environment is quite degraded (inputs are rendered ineffective) or the interventions are not penetrating or accessed by all people to realize any measurable outcome?

This paper examines this phenomenon by taking India as a case. It compares the health outcomes for urban poor and non-poor in contemporary Indian communities against the socio-economic and healthcare developments, over a period of one decade. It also seeks to answer why development interventions are relatively less effective in case of urban poor, whereas it should have been otherwise around because urban poor have more intense poverty conditions and even small inputs would have made a difference.

The analysis is based on data drawn from two large nationwide surveys (NFHS II and III) carried out in 1998–99 and 2005–06, respectively. Surveys have been conducted for urban and rural sections using wealth index (a composite index reflecting on quality of life and possession of household goods).

The findings are likely to provide more insight in to the development programming for urban poor against the backdrop of climate changes.

P-3321-06

The Effectiveness of Heat Early Warning System in South Korea

J. Ha (1)

(1) Korea Environment Institute, Korea adaptation center for climate change, Seoul, Republic of Korea

Heat early warning system is a first heat-wave measure to operate within a heatwave. And this system has been operating in many countries today. Evaluation of the effectiveness of heat early warning system may be utilized to present a further improvement. And, these days, it has been reported that the operation of heat early warning system brings to a decrease in number of emergency services or deaths related to stroke. The aim of this study is to quantitatively examine the associations between the operation of heat early warning system and the reduction of mortality in South Korea.

In South Korea from 2008 to 2012, heatwaves occurred for a total of 8 times, 26 days. I completed cardiovascular-related death counts in four periods. The four periods were defined as: the days in heatwave and above the threshold, the days in heatwave and below the threshold, the days in non-heatwave and above the threshold and the days in non-heatwave and below the threshold. And, the threshold was defined as the temperature at which the risk of mortality begins to increase with increasing temperature.

The daily average of CVD-related death counts were 19.83 and 20.44 for 18 days in heatwave and above the threshold and 21.13 for 16 days in heatwave and below the threshold, respectively. In case of 1-day lagged effect, the daily average of CVD-related death counts were 18.28 and 21.13 for 18 days in heatwave and above the threshold and 16 days in heatwave and below the threshold, respectively. In summary, the operation of Korea’s heat early warning system has a positive effect on bringing a reduction of deaths caused by heatwave.

P-3321-07

Assessing Health Vulnerability to Climate Change in Morocco: Governance and Adaptation Options

K. Kahime (1); B. Mohamed (2)

(1) Faculty of Sciences Semlalia, Cadi Ayyad University of Marrakesh, Laboratory of ecology & environment, Marrakesh, Morocco; (2) Head, Research Laboratory on Territorial Governance, Human Security and Sustainability (LAGOS), Public law department, faculty of law, economics and social sciences of agadir, Agadir, Morocco

The climate factor plays an important role in host systems critical to life. Its considerable effect on many ecological and biological systems has the potential to increase humans’ vulnerability to climate change. Among these vulnerabilities, human health is highly considered. Actually, in addition to the health risks of extreme weather events, many infectious diseases are expected to change their geographical or seasonal patterns and incidence due to climate change and variability. More specifically, climate change will likely affect the disease lifecycle of several vector-borne diseases - such as Malaria and Leishmaniasis – and water-borne diseases – such as Schistosomiasis. These disregarded diseases still ravage lives covertly in many parts of the Global South and are likely to be a major health burden in the coming years due to climate change and other factors. However, and despite this alarming fact, there is still limited specific scientific evidence in this area that can serve as a relevant reference for policy-making processes in many countries.

In Morocco, infectious diseases are still a public health problem. Despite the adoption of a related domestic policy and the consideration of these diseases as reportable, the number of reported cases - both indigenous and imported - is constantly increasing. Given the knowledge gap in this area, the aim of this research is twofold: 1) Undertaking a vulnerability analysis of possible climate change impacts on infectious diseases in Morocco from an eco-epidemiological and socio-economical approach; 2) Assessment of Morocco’s adaptive capacity and identification of existing gaps which may affect the health security of population in the future with regard to infectious diseases and their interactions with climate change. Throughout the analysis, the policy options needed to effectively monitoring and managing climate change impacts on human health – with a focus on adaptation options specific to Moroccan context – will be highlighted.

P-3321-08

Different heat wave definitions and their association with emergency department visits in seven major cities of South Korea

H. Kim (1); HL. Soo (1)

(1) Seoul National University, School of Public Health, SEOUL, Republic of Korea

BACKGROUND:
On-going climate change is accompanied by an increase in the frequency, duration, and intensity of climate-related extreme events, such as heat waves, droughts, floods, cyclones and wildfires, impacting on human health directly and indirectly.

OBJECTIVES:
We examined the association between heat waves and emergency department (ED) visits in seven major cities of South Korea to understand the health effect of climate change quantitatively. In Korea, heat-wave warning is issued by the weather office if the daily maximum temperature is expected to be higher or equal to 33°C for 2 consecutive days. This definition is the same for all cities in Korea. We also would like to evaluate the effect of different definition of heat-wave using city-wise relative temperature rather than absolute temperature.

METHODS:
Different heat waves were defined as having at least 2 consecutive days with daily mean temperatures at or above the 98th percentile for warm season in each city and with daily maximum temperatures at or above 33°C for all cities. We estimated the relative risks (RRs) of ED visits for heat related, cardiovascular, and respiratory diseases on heat wave days compared with non-heat-wave days using city-specific Poisson generalized linear models adjusted for daily mean temperature, relative humidity, day of the week and time trend. The analysis used time-series case-crossover with 28-day stratum to estimate the increase risk of ED visits associated with heat-wave, then and compared the estimates from time-series analysis with the results from time-stratified case-crossover analysis. We also estimated the association between ED and duration of heat-wave with two different definitions using time-series
RESULTS:
Heat waves defined as having at least 2 consecutive days with daily maximum temperatures at or above 33°C for all cities were associated with RRs of 2.79 (95% CI: 1.84, 4.23), 2.19 (95% CI: 1.39, 3.46), and 1.5 (95% CI: 1.07, 2.11) for heat-related ED visits in Seoul, Gwangju, and overall across all cities respectively, and heat waves defined as at least 2 consecutive days with daily mean temperatures above the 98th percentile for warm season in each city were associated with 2.44 (95% CI: 1.47, 4.06), 2.29 (95% CI: 1.66, 3.16), 1.74 (95% CI: 1.07, 2.82), and 1.80 (95% CI: 1.44, 2.25) for heat-related ED visits in Daegu, Seoul, Gwangju, and overall across all cities respectively. These estimates indicated the significant increases in the number of ED visits on heat-wave days compared with non-heat wave days. However, we did not define heat waves in terms of estimates suggested positive associations between heat waves and heat-related ED visits and varied among the cities. Most estimates of heat wave risk for cardiovascular and respiratory ED visits were weaker than those for heat-related ED visits although these findings were not statistically significant. However, the estimates of heat waves risk for cardiovascular ED visits were 1.34 (95% CI: 1.10, 1.63) under 98th percentile temperature and 1.39 (95% CI: 1.09, 1.77) under 98th percentile temperature in 65+ year age group. The time-stratified case–crossover analysis produced results similar to those found in the time series analysis for the associations between heat waves and ED visits. The estimated risk for heat-related ED visits for every 1-day increase in heat wave duration was the highest in Seoul with RR of 1.49 (95% CI: 1.29, 1.72), and the estimates of 1.48 (95% CI: 1.17, 1.88), 1.28 (95% CI: 1.04, 1.58), and 1.20 (95% CI: 1.10, 1.31) significantly indicated the positive associations between heat wave duration and heat-related ED visits in Daegu, Gwangju, and overall across all cities respectively.

CONCLUSIONS:
Our findings using different definitions and character for heat waves and ED visits data from NEDIS provide supportive evidences of the health effect of heat waves for further study and policy makers to reduce the health risk of heat waves varying among areas in South Korea.

P-3321-10
Integrating climate information into decision support tools for public health
R. Lowe (1) ; X. Rodó (1)
(1) Institut Catalá de Ciències del Clima (IC3), Climate dynamics and impacts unit, Barcelona, Spain

More frequent and severe extreme climatic events have been accompanied by the accelerated emergence of new infectious diseases, widespread climate-related disease epidemics directly impact the health of local populations, strain healthcare systems, and cause substantial economic loss. Given climate change, globalisation, increased air travel and connectivity with endemic areas, there is a need to strengthen local resilience to infectious disease threats via innovative decision support systems. Seasonal climate forecasts provide an opportunity to incorporate presurprisory climate information into decision support systems for climate-sensitive diseases. This aids epidemic planning months in advance, for diseases such as dengue fever, cholera and malaria.

Here, we present a versatile Bayesian hierarchical statistical mixed model framework, designed to quantify the extent to which climate indicators can explain variations in disease occurrence and to develop region-specific seasonal climate forecasts providing a diagnostic for evaluating the potential for future epidemics. We use historical data from area-wide sentinel systems in Latin America and South East Asia. We also illustrate how model results could be translated into actionable warnings for public health decision makers.

P-3321-11
Community-Based Heat-Stress Vulnerability Assessment with Monitoring, Social Survey, and Crowd-Sourcing Technology for Health Adaptation
SC. Lung (1) ; DW. Wang, (2) ; SH. Tu (3) ; PS. Liao (3) ; MC. Chen, (2) ; SW. Chen (2) ; LJ. Chen (2) ; CY. Lin (1) ; WC. Wang, (1) ; FM. Huang, (2)
(1) Academia Sinica, Research Center for Environmental Changes, Taipei, Taiwan; (2) Academia Sinica, Institute of Information science, Taipei, Taiwan; (3) Academia Sinica, Research center for humanities and social sciences, Taipei, Taiwan

Increased mortality was observed on heatwave days worldwide in recent years. According to the projected mortality changes in high income Asian countries such as Taiwan in 2030 and 2050 by World Health Organization, the increase in heat-related mortality is the highest compared to mortality change of all other potential causes due to climate change. A proactive heat-stress vulnerability assessment was conducted in support of reducing health risks and formulating health adaptation strategies in Taiwan, with emphasis on community-based heat-stress exposure assessment and response-capacity evaluation using social surveys and crowd-sourcing surveys. This presentation showcases scientific findings from this trans-disciplinary research framework using Taiwan, a sub-tropical island, as an example. A novel two-tier heat-stress vulnerability assessment was conducted with multiple innovative facets. First, physical (heat), chemical (air pollution), and social (behavior and response capacity) aspects of vulnerability were assessed with the crowdsourcing technology as well as more established methodologies in atmospheric chemistry monitoring/ modeling and survey research. Secondly, both direct (heat) and indirect (air pollution) exposure pathways due to body temperature were assessed. Thirdly, taking advantages of the bottom-up and top-down approaches, a two-tier framework is adopted to examine important factors and associated physical, chemical, and social mechanisms at the community level as well as to identify the spatial distribution of vulnerable groups and areas at the national scale.
level. Fourthly, the controllable factors of exposure to heat-stress and air pollutants and those of individual and community response capacities were targeted so that the health risks can be minimized by either interrupting the exposure pathway or enhancing the response capacity of the exposed populations. Lastly, the vulnerability factors studied correspond directly to the respective policy options in social and health promotion programs and heat–warning system establishment so as to facilitate the science–policy dialogue. Recommendations for health adaptation strategies were made accordingly to enhance resilience of individuals and communities facing the challenges of more frequent heat waves in the future.

P-3321-12

Climate Change, Episodic Drought, and Valley Fever Epidemic in California

M. Matlock (1)
(1) University of California Irvine, Public Health, Irvine, CA, United States of America

Valley Fever (Coccidioidomycosis) is a reemerging infectious disease that is endemic to the southwestern United States (California, Arizona, Utah, Texas, Nevada, and New Mexico), Mexico, Central America, and South America. The disease is transmitted to humans through inhalation of spores from fungi Coccidioides immitis or Coccidioides posadasi, which typically occur in separate regions but manifest the disease similarly. Environmental factors associated with low humidity, sandy soil, and less than 20 inches of rain per year favor the persistence of the fungi and risk of infection. The recent increase in incidence of Coccidioidomycosis in several California counties has been attributed to large amounts of dust due to several years of drought followed by rainy seasons. However, no research has been conducted to unpack the complex linkages between climate change, soil fungal diversity, and social conditions that lead to human vulnerability. We are investigating communities in the deserts of the Southwest United States, such as Borrego Springs, California, as part of the “front line” of global climate change and regional drought mitigation. Borrego Springs faces an impending water crisis, with some studies suggesting the town will run out of economically viable water within 30 years. With El Nino Southern Oscillation (ENSO) conditions expected to bring rain to the region after a prolonged drought, we hypothesized significant increase in the incidence of Coccidioidomycosis. The unknown risk of Coccidioidomycosis, the longevity of infection, and the lack of proper diagnosis are expected to contribute to increasing burden of this disease in the region. This study further explores local and regional health responses, and the challenges associated with linking Coccidioidomycosis climate change and regional drought mitigation. The study tests hypotheses linking Coccidioidomycosis incidence to soil moisture and seasonality for California communities. The study addresses barriers, benefits, risks, and trade-offs of local health responses and we discuss the integration of climate mitigation and adaptation options to reduce the negative impact of climate change on Coccidioidomycosis prevalence in a vulnerable community.

P-3321-13

The international negotiations under the United Nations Framework Convention on Climate Change: Insertion of the Health Sector and Implications for Foreing Policy

R. Milhomem (1)
(1) Fiocruz, Brasília, Federal District, Brazil

The scenarios outlined by the Intergovernmental Panel on Climate Change and research centers around the world reaffirm the intrinsic relationship between Climate Change and Human Health. Nevertheless, the international negotiations under the United Nations Framework Convention does not fully reflect the concerns, prevention, promotion and recovery of global health. The detachment between the scientific world and the reality embraces a serious systemic risk that threatens human and planetary survival.

The time is ripe for concrete insertion of Health concerns in climate negotiations. With the creation of the Durban Platform, a new climate protocol is being negotiated, able to determine all future developments in the fight against Climate Change.

In this sense, the interrelationships between domestic and international policy conform to the formation of the international position of a country. Thus, the health sector has the potential to offer successful solutions to the climate negotiations, bringing new complexity able to change the whole structure of the negotiation and its outcome favorably. To contribute to these discussions, a number of policy recommendations to be used directly into the climate negotiations, as in the format and language of international treaties.

This is the historical and timing of insertion of Health concerns in discussions on Climate Change, as they determine the success of the agreement and cooperation between countries.

P-3321-14

Impact of Climate Change on Child Health

Z. Mina (1)
(1) National University of Sciences and Technology, School of Social Sciences and Humanities (S3H), Islamabad, France

Climatic shocks have adverse economic consequences for both developed and developing nations. However, the economic costs are far greater in developing nations which face greater risks and vulnerabilities and lack the resources to absorb them (UNDP, 2007; World Bank, 2010). Given a rise in the incidence of such shocks, recent development literature has articulated increasing importance to studying their impacts. For children, climate change-induced shocks exacerbate vulnerabilities and place them at increasing risk. Specifically, some of the risks include separation from families, deprivation in terms of schooling, adverse impacts on children’s nutrition and learning outcomes, and increased susceptibility to abuse and exploitation. Therefore, studying the impact of such shocks on child welfare is imperative. Children are not only most at risk but also the most effective means in fostering long-term change.

The particular focus of this study is to analyze the impact of two different climatic shocks: floods and drought, on child human capital across Ethiopia, India, Peru and Vietnam – countries with diverse socio-economic backgrounds. Human capital, in this context, subsumes both child learning and health outcomes. The discussion of the impact of climate shocks on human capital is made in the context of both income and substitution effects and the possibility of a positive climatic shock impact is explored. If the income effect dominates we can expect a negative impact on our outcome variables, while the converse is true if the substitution effect dominates. Additionally, the study aims to elaborate the role of child, parental, household and community characteristics as well as institutional help in buffering these climatic shocks.

The data source is the Young Lives Project* and cross-sectional household data is utilized for the year 2009. The study examines the data on the older cohort of children, whose lives were documented from ages 14 – 15, and covers both urban and rural areas. The enrolment rate and three measures of cognitive ability: Peabody Picture Vocabulary Test (PPVT), CLOZE test and Mathematics test scores are used as proxies for child learning outcomes. The health outcome variables being studied are the WHO developed Body Mass Index (BMI) z-scores and Height for Age (HFA) z-scores.

* Young Lives is a 15-year survey investigating the changing nature of childhood poverty in Ethiopia, India (Andhra Pradesh), Peru and Vietnam (www.younglives.org.uk). Young Lives is funded by UK aid from the Department for International Development (DFID) with co-funding from 2010–2014 by the Netherlands Ministry of Foreign Affairs and from 2014–15 by Irish Aid.
The Inuit Traditional Knowledge for Adapting to the Health Effects of Climate Change (IK-ADAPT) project was launched in May 2012. Funded through the Canadian Institutes for Health Research (CIHR), IK-ADAPT combines scientific research with Inuit traditional knowledge to foster an evidentiary base to inform policy and programming needed to adapt to the health effects of climate change. Working with Canadian Inuit communities in the Inuvialuit Settlement Region, the Northwest Territories, Nunavut, and Nunatsiavut, as well as knowledge users at multiple levels, the project is examining ways to preserve, promote, and disseminate Inuit knowledge in order to prevent, prepare for, and manage the health impacts of climate change. Having just come to the end of its final phase, this presentation provides an overview of the project, shares results from projects conducted under IK-ADAPT, and discusses areas for future research. This includes Canadian Inuit communities and northern health systems in light of a rapidly changing climate.

P-3321-16

Arsenic Contamination in drinking water and Valuing Health Damages: A case study of Bihar

BK. Thakur (1)

(1) National Institute of Industrial Engineering (NIITIE), Mumbai, General Management, Mumbai, Maharashtra, India

The present study attempts an empirical investigation on the health effects of Arsenicosis on individuals in the rural areas of Bihar. Systematic random sampling was used for the selection of households and 388 households were selected from Maner and Shahpur blocks of Bihar. We used a field test to test the arsenic contamination in the water samples which were collected from each household. The water test results reveal that Maner’s drinking water is more contaminated than Shahpur’s drinking water. The mean concentration of arsenic contamination for entire study area, Maner and Shahpur is found to be 89.31 ppb/l, 111.34 ppb/l and 61.93 ppb/l respectively. The study estimates incidence rate of Arsenicosis diseases for three categories of sample: for the entire sample surveyed, females and males. The incidence rate is highest among females and the lowest among males. It predicts Binomial (probit) probability of success in the outcome, which is defined as the probability of observing the Arsenicosis diseases for surveyed household, is estimated and found to be 0.42. Arsenicosis disease is regressed on a set of explanatory variables and found to be significant and positively related to the Arsenicosis diseases. This indicates that the household which is using poor water sources is reporting more cases of illness. This also reveals those who used drinking water from hand tube wells are more vulnerable to the Arsenicosis diseases as most of the sample households draw water from hand tube wells. The study also reveals the awareness is not matched with defensive activities i.e. water purification. It reveals that if household is aware about the water source there is decrease in Arsenicosis diseases. The study also finds doctor visit, work loss, and arsenic level as significant and positively related to the Arsenicosis diseases. We find arsenic contamination level is significant and positively related to household defensive activities on water purification. This indicates that the higher income household installed more water purification devices, Adequate of sanitation is significant and positively related to defensive activities. The results per capita income and is an important finding. Depth of the hand tube well is significant and positively related to water purification strategy. This indicates that there are the lesser number of households have deep tube wells. One probable reason to this is that the more the depth of the hand tube well, better the water quality is. Water source and awareness are significant. The study estimates the cost of illness to the household due to contaminated drinking water that comprises treatment cost and wage loss. The study finds that the poor households are more affected than the well off. The annual wage loss cost of treatment and cost of illness for sample households are estimated as INR 2437.92, INR 5942.40 and INR 8380.32 respectively. The total annual cost of illness for both the block is estimated as INR 26597961.6. The defensive activities undertaken by higher income group household are taking water purification while the lower income group household could not undertake the water purification. The cost of illness may be taken as the willingness-to-accept by the affected household. Therefore, providing safe drinking water benefits both social and economic value. The results of the present study indicate that water source and awareness are the two most significant factors on both individual’s health and household’s economic condition. With safe water sources, the households are left with no choice but to use the existing available source for drinking water. The government may use various channels to make the households and rural areas to use the existing safe water supply to all the households. The result of this study would provide policy inputs to the policy makers to make their strategies more effective in providing drinking water which may help to reduce the Arsenicosis in a cost-effective and sustainable manner.

P-3321-17

2015 Lancet Commission on Health and Climate Change: Emergency Actions to Protect Human Health

N. Watts (1); N. Adger (2); J. Blackstock (3); P. Byass (4); W. Cai (5); T. Colbourn (6); M. Collins (7); P. Cox (7); J. Depledge (8); P. Drummond (9); P. Ekins (9); V. Galaz (10); H. Graham (11); M. Grubb (12); P. Gong (13); A. Haines (14); T. Oreszczyn (15); H. Montgomery (9); K. Warner (16); A. Costello (7)

(1) Lancet Commission on Health and Climate Change, London, United Kingdom; (2) University of Exeter & IPCC (AR5 WGII Chap. 12), Exeter, United Kingdom; (3) University College London, Centre for earth system sciences, Umea, Sweden; (4) University of Cambridge, Cambridge, United Kingdom; (5) Tsinghua University, Beijing, China; (6) University College London, Institute for global health, London, United Kingdom; (7) Exeter University, Exeter, United Kingdom; (8) University of Cambridge, Cambridge, United Kingdom; (9) University College London, Institute for Sustainable Resources, London, United Kingdom; (10) Stockholm Resilience Centre, Stockholm, Sweden; (11) University of York, York, United Kingdom; (12) University College London, Institute of Sustainable Resources, London, United Kingdom; (13) Tsinghua University, Beijing, China; (14) London School of Hygiene and Tropical Medicine, Social and Environmental Health Research, London, United Kingdom; (15) University College London, London, United Kingdom; (16) University College London, Centre for global health research, London, United Kingdom.

In 2009, the UCL–Lancet Commission on Managing the Health Effects of Climate Change called climate change “the biggest global health threat of the 21st century.” Five years on, a new multidisciplinary, international Commission has formed to map out a comprehensive response to climate change and to identify the least attainable standards of health for populations worldwide. The Commission represents a collaboration between over 80 European and Chinese climate scientists and geographers, social and environmental scientists, biodiversity experts, engineers and energy policy experts, economists, public health experts and public policymakers – all seeking a response to climate change which is designed to protect and promote human health.

The Commission’s work is divided in to five inter-related chapters. It begins by conducting a review of the climate science and its subsequent impacts on human health since 2009 before then outlining the options around four central themes: community resilience and adaptation in low-income countries; energy choices and technical solutions; economic tools and the finance; and political mechanisms. At every point, the Commission understands the policy solutions to the extent that they improve public health.
The Commission’s work suggests that current greenhouse gas mitigation policies and strategies do not pose an unacceptably high and potentially catastrophic risk to human health. In response to this, the Commission then concludes and describes a path whereby tackling climate change, can become the greatest global health opportunity of the 21st century.

It also notes the unique and crucial role of the health community in responding to climate change. This is described in terms of the importance of adequate health impact assessments to guide mitigation and adaptation policy; the role of health and health systems as a tool for building community resilience; and the power of the health professional as a messenger that can communicate the risks and opportunities of climate change as local, immediate, and personal.

The Commission’s work has now been completed, and will be published in The Lancet in May 2015.

3322a - Representation of technological dynamics and societal transformation

ORAL PRESENTATIONS

O-3322a-01
Unprecedented urbanization and challenges to model them in IAMs

S. Dhakal (1)
(1) Asian Institute of Technology, School of Environment, Resources and Development, Pathumthani, Thailand

World has witnessed unprecedented urbanization— with 2.8 billion urban residents added between 1950 to 2000 and more 2.8 billion more by 2050. Projections show that future population rise will mostly comprise of the urban population. Rapid urbanization leads into rapid rise in energy use and CO2 emission since such urbanization in taking place rapidly in economically growing regions of the developing world where per capita CO2 emission in urban areas are far higher than the national averages. Our analysis shows that urbanization is the key and irreversible global trend for now. Recent IPCC Mitigation report makes it explicitly clear that the next 2–3 decades are crucial for low carbon development and our ability to orient new urbanization to low carbon pathway will define our ability to tame global emissions trends. New urbanization calls for rapid deployment of infrastructure in small and medium scale cities and lock-on cities into particular carbon trajectory. For example, China has unveiled a new urbanization plan in March 2014 to boost urbanization to 60% by 2020 that aim to invest 7–8 trillion dollars in urban infrastructure by 2020. The implications of the choice of urban forms, urban design and infrastructure in new urbanization on global emission occurs though embodied emission in materials used in infrastructure, such as cement, steel, aluminum and others which are carbon intensive as well as through the direct emissions due to use of those infrastructure which lock urban system into particular technological choice. Studies based on Integrated Assessment Models have shown that a dedicated focus on urban barriers for 2000–2050 would lead to about 1000 GtCO2 to stay under 2°C climate stabilization; some early studies are showing that over one third of that could come from infrastructure sector alone assuming residents in the developing countries catch up to the level of per capita infrastructure stock of the average developed country residents. However, given the enormous potential of urbanization to influence global carbon emission and its multi-faceted implications, our analysis suggests that the ability to model urbanization and its implications in the current Integrated Assessment Models and other large scale global models remains extremely poor. We argue that the next frontier in global and regional IAM models lie in addressing the full scale implications of the type and extent of urbanization in economic, infrastructural, social, geosphere and bio-spherical domains. This presentation will dwell on these issues and opens much needed dialogues and discussions on how to take-on these challenges in the modelling community to develop a new generation of Integrated Assessment Models.

O-3322a-02
Title not communicated

P. Ciais
Abstract not communicated

O-3322a-03
Links between energy systems models and economic models: learning from the IEA ETSAP experience

B. O Gallachoir (1); J. Glynn (1)
(1) University College Cork, Environmental Research Institute, Cork, Ireland

In a climate constrained future, hybrid energy-economy model coupling gives additional insights into interregional competition, trade, industrial delocalisation and overall macroeconomic consequences of decarbonising the energy system. Decarbonising the energy system is critical in mitigating climate change. In this paper, we summarise modelling methodologies developed in the IEA ETSAP (Energy Technology Systems Analysis Programme) community to assess economic impacts of decarbonising energy systems at a global level and at a national level.

ETSAP is a unique network of energy modelling teams from approximately seventy countries involving 177 institutions over the world, well beyond the number of its contracting parties, who are the governments of eighteen countries and the European Commission. ETSAP was one of the multilateral technology initiatives (formally called implementing agreements) initiated in 1976 under the aegis of the IEA. ETSAP evolved from initially analysing existing tools to evaluate R&D strategies to the combination of the energy flow optimisation approach with macroeconomic top-down modelling, technology learning and stochastic modelling.

This paper summarises a range of different methodological approaches to developing linkages between energy systems modelling and economic modelling, drawing on a significant and rich body of analysis. The energy-economy model coupling methodology is based on the techno-economic linear optimisation engineering TIMES models. TIMES is a techno-economic model generator for local, national or multi-regional energy systems, which provides a technology rich basis for estimating energy dynamics over a long-term (20–50 years), multi-period time horizon. TIMES computes a time varying inter-temporal partial equilibrium on inter-regional markets. The objective function maximises total surplus. This is equivalent to minimising the discounted total energy system cost while respecting environmental, technical and scenario constraints. This system cost includes investment, operation and maintenance and fuel import costs, less export income, terminal technology values and salvage values. The top-down (TD) macroeconomic models range from single producer–consumer production function models, to multi-regional structural computable general equilibrium (CGE) models. The paper compares soft–linking approaches (e.g. between TIMES and CGE models) and hard–linking (e.g. TIMES–MACRO).

The analysis demonstrates that the range of economic impacts of decarbonisation is regionally dependent upon the stage of economic development, the level of industrialisation, energy intensity of exports, and competition effects due to rates of relative decarbonisation. Developed nation’s decarbonisation targets are estimated to result in a manageable GDP loss in the region of 2% by 2050. Energy intensive export driven developing countries such as China and India, and fossil fuel exporting nations can expect significantly higher GDP loss of up to 5% GDP per year by mid-century.

The national modelling studies outlined here show that
burden sharing rules and national revenue recycling schemes for carbon tax are critical for the long-term viability of economic growth and equitable engagement on combating climate change. Traditional computable general equilibrium models and energy systems models solved in isolation can misrepresent the long run carbon cost and underestimate the demand response caused by technological paradigm shifts in a decarbonised energy system. The approaches outlined here have guided the first evidence based decarbonisation legislation. They continue to provide additional insights as increased sectoral disaggregation in hybrid modelling approaches is achieved.

The paper concludes with a number of challenges that are necessary to address, including i) the uncertainty in exchanging price information from BU to TD models in cost-effective ways; ii) the difficulty in capturing satisfactorily the changes in investment flows that arise due to large structural changes in the energy system.

Developing pathways for zero poverty and zero emissions

H. Winkler (1)
(1) University of Cape Town, Energy Research Centre, Rondebosch, South Africa

Poverty eradication has been a priority of developing countries for a long time, and this is reflected in the UNFCCC. Much more recently, framing a global goal on mitigation has been advanced, aiming at net zero emissions by 2050. In the post-2015 development agenda, the first Sustainable Development Goal is to "end poverty in all its forms everywhere". How to achieve zero poverty and zero emissions?

The problem is easy to state, any ‘solutions’ are hard to realise. It is easy to support Oxfam’s excellent slogan, to “make poverty history”. And relatively easy to model zero emissions - though at what cost. Yet in developing countries, climate action needs to be in a way that reduces poverty and inequality.

Among South Africa’s many development challenges, the National Development Plan identifies poverty and inequality as the foremost [1]. The same plan also refers to reducing emissions, and the climate policy of GHG emissions following a ‘peak, plateau and decline’ trajectory [2]. To achieve both zero poverty and emissions in South Africa’s energy economy is challenging [3].

Ongoing research seeks to model multiple development–climate objectives in SA’s energy economy, aiming to provide information that is credible, analytically rigorous and is a story that enables interest to imagine themselves in a different future. This builds on a long–standing energy model development at the ERC, and more recently links with top–down economy–wide models, also with teams in other developing countries [4, 5].

Scenario of deep decarbonisation for South Africa – 14 Gt CO2-eq in SA’s energy sector (scenario 14 Gt energy) from 2016 to 2050 [3] – and meeting the multiple development objectives is possible. The results of linked modeling of the 14 Gt energy scenario suggest it is technically plausible, but has negative welfare effects.

Earlier work has made the case instruments such as sustainable development policies and measures (SD-PMs) would better fit the action in developing countries [6–11]. But if zero poverty cannot be achieved, as recent results suggest, what is the implication for ambitious climate action? The ERC’s research agenda will continue to analyse these wicked problems, and can only benefit from exchange of creative thinking with others grappling with this trilemma [12].

We do not think, however, that mathematical models alone will provide any ‘solution space’ (we tend to think of it more as a process). Through experience with long–term mitigation scenarios for South Africa [13, 14] and the Mitigation Action Plans and Scenarios (MAPS) programme in Brazil, Chile, Colombia and Peru, we think that the co–production of knowledge and its use of facilitated stakeholder process is powerful in helping a transition to zero poverty and zero emissions societies.

To realise zero poverty and zero emissions, a new social contract is needed [15]. What might the general idea of a social contract look like in a story of a different South Africa? SA has unemployment of 25% (40% by a broader definition), with even higher shares among youth. This emerged with past industrial policy focused on energy intensive sector growth. But if employment were reduced in mining, energy supply and beneficiation, where would it be created? One cannot simply assume unemployment is absorbed by agriculture and textiles, where growth is possible, and may be helped by a small wage subsidy. We will continue to research, in various ways, the goals of zero poverty and zero emissions.

Tipping point policies for energy transformation - assessing their likely effect

M. Jaccard (1)
(1) Simon Fraser University, Resource and Environmental Management, Burnaby, British Columbia, France

A global climate agreement will not soon lead to a single global carbon price. But 10 years of efforts by individual and groups of jurisdictions have provided valuable lessons on the design of other types of market-oriented and regulatory policies that can foster tipping points in the costs (financial and psychological) of energy system transformation. Assessing the likely effect of such policies is a challenge for energy–economy–emissions modelers. This talk summarizes some of the challenges and possible solutions.

Development of pathways: their mix of endogenous and exogenous uncertainties and their future under changing climate

S. Kypros (1) ; J. Glynn (2) ; B. O Gallachoir (2) ; M. Gargiulo (3) ; A. Lehtila (4)
(1) Honorary Senior Scientist of Paul Scherrer Institut, LEA, Villigen, PSI, Switzerland; (2) UCC, Cork, Ireland; (3) E4SMA, Turin, Italy; (4) VTT, Espoo, Finland

We generate efficient climate change mitigation scenarios of low emission pathways for carbon dioxide and other greenhouse gases (GHGs) such that global warming remains below 2 °C with high probabilities. Then, we balance the cost of mitigation for different world regions, the associated budget and the required costs for an efficient reduction of GHGs emissions. The prerequisite is that the CO2 equivalent concentration will remain similar to the present levels while the temperature rise will stay below 2 °C of warming. The associated budget of Remaining Carbon Equivalent Emissions Quotas (RCEEQ) is 273 GtC for CO2 plus another 180 GtC-eq. for other GHGs, valid from the period 2020 onwards, and is imposed as constraint. This value of RCEEQ is in accordance with the
Summary Report for Policy Makers of the 5th Assessment Report (AR5) of the UN Framework Convention on Climate Change.

Then, we evaluate interregional capital transfers originated from the industrialized world to support mitigation efforts of low income regions to ensure their participation to a binding agreement. Interregional equity transfers are established via a market of emission permits and are propagated across countries in Austria to redistribute the initial endowments of permits. This refers to the effort-sharing or the resource-sharing regimes. Another option considered in the analysis is the introduction of interregional capital transfers in financing a huge joint implementation program covering fully the extra cost of a carbon–free energy system of developing countries up to a stage of full compensation of the economic losses for low income regions.

As all world regions profit from the reduction of damages under the RCEEQ constraint, it makes also sense to estimate the socio-economic pathways, consistent climate scenarios, and compensation schemes for their mitigation cost net of benefits. This capital transfers could take place with the help of burden sharing and emissions trade schemes or through joint implementation projects. Therefore, the study undertakes a sensitivity analysis where a) different degrees of cumulative RCEEQ constraints are assumed to differentiate on the one hand capital transfers that assure fairness and equity b) different allocation schemes apply while in the case of full compensation we consider the needed capital transfer net of damages and finally c) a scenario of late actions under the same RCEEQ constraints is introduced to investigate potential advantages and disadvantages in terms of regional GDP impacts and the timely restricted overshooting of temperature change. Finally we conclude on scenarios and compensation schemes that allow to define a well-balanced set of regional impacts.

This generation of efficient and equitable scenarios became possible using the Integrated Assessment Model TIA–MACRO, a technology rich, hybrid general equilibrium model integrating a full scale bottom–up engineering model with macroeconomic top–down models that allow an in-depth physical exposure analysis for an ensemble of climate projections with a regionally–calibrated version of a global Computable General Equilibrium (CGE) model. The economic effects, output losses, are estimated per region in terms of Gross Regional Product change till 2100. Losses are estimated for two disaster risk management scenarios: with and without adaptation to changing flood conditions. Our results show that in Italy, because of climate change, current aggregated ensemble–average Expected Annual Output Losses increase fourfold without adaptation, exceeding 600 million Euro per year by the end of the century. When extreme events and the tails of their distributions are included, even for a partial analysis focused on extremes, damages are seen to rise significantly, e.g. with an estimated increase to € 40 billion due to riverine flooding events alone by the end of the century. These highlight the need to consider the distribution of impacts, as well as the central values.

Economics of flood risk in Italy under current and future climate
L. Carrera (1) ; G. Standardi (2) ; E. Koks (3) ; L. Feyen, (4) ; J. Mysiak (2) ; J. Aerts (5) ; F. Bosello (6)

(1) FEEM – Fondazione Eni Enrico Mattei and Euro–Mediterranean Center on Climate Change, Venice, Italy;
(2) FEEM – Fondazione Eni Enrico Mattei, Venice, Italy;
(3) Institute for Environmental Studies, VU University Amsterdam, Amsterdam, Netherlands;
(4) IREC, Ispra, Italy;
(5) VU University Amsterdam, IVM, Amsterdam, Netherlands;
(6) University of Milan, FEEM, and CMCC, Dep. of economics, Milan, Italy

We estimate current and future economic impacts of fluvial flood risk in Italy in view of climate change under a business-as-usual emissions scenario. The methodology combines a high resolution spatial flood hazard and exposure analysis for an ensemble of climate projections with a regionally-calibrated version of a global Computable General Equilibrium (CGE) model. The economic effects, output losses, are estimated per region in terms of Gross Regional Product change till 2100. Losses are estimated for two disaster risk management scenarios: with and without adaptation to changing flood conditions. Our results show that in Italy, because of climate change, current aggregated ensemble-average Expected Annual Output Losses increase fourfold without adaptation, exceeding 600 million Euro per year by the end of the century. When extreme events and the tails of their distributions are included, even for a partial analysis focused on extremes, damages are seen to rise significantly, e.g. with an estimated increase to € 40 billion due to riverine flooding events alone by the end of the century. These highlight the need to consider the distribution of impacts, as well as the central values.

O-3322b-04
Title not communicated
M. Aglieatta
Abstract not communicated

CIECIA: A New Climate Change Economic IAM and its Assessment of Global Cooperating Abatement Schemes
Z. Wang (1) ; J. Wu (1) ; G. Gu (2) ; C. Liu (1)

(1) Institute of Policy and Management, Chinese Academy of Sciences, Beijing, China; (2) East China Normal University, Shanghai, China

From the perspective of global economic general equilibrium, this study developed a new climate change IAM named CIECIA. The economic core of this IAM is a multi-country–sector general equilibrium model. The endogenous technology progress mode is introduced into CIECIA. Based on this IAM, three assessment principles of global cooperation abatement schemes are also evaluated. Effectiveness, Feasibility, and fairness are presented. This study simulated and analyzed 6 kind of main global cooperating abatement schemes. The simulated results indicate that all the selected schemes can satisfy the climate protect target to 2100. Thus, they are all effective schemes. However, the schemes have quite different
feasibilities and fairness. The Stern Scheme benefits the developed countries, but is unfair to the developing countries. The Nordhaus Scheme promotes the economy of developing countries. However, it will have negative impact on the benefits of developed countries. The per Capita Emissions Convergence Schemes benefit the developed countries, and the Pareto Improvement Scheme which is developed from the Steady Economic Growth Scheme balances the fairness and feasibility in carbon abatement process and realize the Pareto improvement of economic utilities in all the participating countries. Thus, the Pareto Improvement Scheme is the most reasonable global cooperating abatement scheme.

3322 – POSTER PRESENTATIONS

P-3322-01

Energy-economy-environment applied models: insights, developments and limitations

R. Bibas (1) ; J. Lefèvre (1)

(1) International Research Center on Environment and Development (CIRED), Paris, France

The IPCC Fifth Assessment Report shows the end of the controversy between top–down and bottom–up models that has been witnessed in previous reports. State-of-the-art models have evolved towards more integration, thus becoming ever more complex. In this new era of integrated and hybrid models, models are classified according to criteria such as coverage, flexibility and sectoral detail rather than the deep mechanisms themselves within the model.

The current approach to tackle the uncertainties is to create scenario ensembles to compare the reactions of models. Indeed, this top–down approach examines model results rather than starting with a description of mechanisms and structures to characterize the outcome of model behavior. By contrast, we seek to complete this type of studies by developing a bottom–up approach to create a taxonomy based on the depiction representation and the implicit assumptions relative to the models. Therefore, we propose to examine the constitutive building blocks of the model to control the structural uncertainty inherent to the forward–looking analysis. Thus we posit that the full picture is needed to understand the forward looking potential of each model. Our goal is to understand the deep mechanisms driving the joint evolution of the energy, economy and environment systems.

This paper presents an updated and thorough taxonomy of the state-of-the-art models from the Fifth Assessment Report. The taxonomy builds on the existing taxonomy, in particular on the historical (and obsolete) opposition between top–down and bottom–up models to bring to light the building blocks of the models. Understanding the building blocks of these models gives an overview of their inner mechanisms as well as the explicit or implicit assumptions in the model. Furthermore, it presents all models in an unified manner in a summary table with a unified vocabulary. The comprehensive review of the models allows a relevant assessment of their potential to produce forward–looking scenarios to reveal insights about the decisions to be made for climate change mitigation. This paper then examines the forward–looking analysis potential of each approach and concludes on their respective uses.

This bottom–up approach is a complex endeavor, but the analysis of building blocks constitutive of the models sheds light on the historical (and obsolete) oppositions between several groups of deep mechanisms: demand drivers in relation with structural changes, the incorporation of technology, the representation of economic choices and the evolutionary factors of society. Therefore, we want to understand the drivers of the transition both in the short run and in the long run to discuss the global articulation between climate change mitigation and economic development.

P-3322-02

Transparency in Integrated Assessment Modeling

R. Cale (1) ; DA. Stainforth (2)

(1) UC Berkeley, Berkeley, France; (2) London School of Economics, Grantham Research Institute, London, United Kingdom

The basis for concern over anthropogenic climate change is founded in the physical sciences but the rationale for action is rooted in social sciences and economics. Integrated assessment models (IAMs) are the main tools for combining physical and economic analyses to assess climate change policy. To a large extent, however, these models are black-boxes to those outside the integrated modeling community. Economic assessments of climate change consequently risk misrepresenting physical understanding of the climate system, while physical science may fail to focus on the most salient issues for economic and policy assessments. Here we open the lid and resolve physical science differences between three of the most studied IAMs. We argue for greater cross–disciplinary transparency in this highly policy–influential field and for greater debate over the appropriate level of model complexity. Researchers, and research funders, should resist the temptation to increase complexity beyond the point where disagreements and uncertainty about modeling assumptions can be easily identified and debated openly with relevant experts. We suggest alternative ways to improve representativeness and extend the use of IAMs while maintaining and promoting transparency.

P-3322-03

Is there a reason for strong mitigation? The role of time preference, inequality aversion and catastrophes

F. Dennig (1) ; M. Budolfson, (2) ; M. Fleurbaey (3) ; A. Siebert, (4) ; R. Socolow (5)

(1) Princeton University, Princeton, New Jersey, United States of America; (2) Princeton University, Uchv/wws, Princeton, New Jersey, United States of America; (3) Princeton University, Woodrow Wilson School, Princeton, United States of America; (4) Princeton University, Climate futures initiative, Princeton, New Jersey, United States of America; (5) Princeton University, Mechanical engineering, climate futures initiative, Princeton, New Jersey, United States of America

The debate about how strong and quick mitigation policy should be in the coming decades has mostly revolved around the discount rate, with the conclusion that only a discount rate much lower than ordinary market rates can justify drastic action toward abating emissions. There have been, however, some questions about what the relevant market rate is (the riskless market return is actually quite low), and some explorations of more pessimistic estimates of the extent of damages for temperatures rising more than 3°C above the pre-industrial temperatures.

In this paper, we develop a variant of RICE, called NICE (for Nesting Inequalities, Climate and Economy), which separates the ethical parameters of the social objective from the behavior of the economic agents and introduces empirical estimates of inequalities in living standards within the twelve regions of RICE.

The first feature (separating ethical parameters from
behavior) enables us to take the agents’ saving behavior as given while we test the policy implications of various configurations of the key ethical parameters of the social objective: the pure rate of time preference and the degree of aversion to inequality across and within generations. The second result is that inequality aversion, due to the implied value of protecting the future poor from strong damages. A progressive distribution of abatement costs also reinforces mitigation in the optimal path, and more so with strong inequality aversion.

The general conclusions of this paper are: 1) inequality aversion between and within generations is a crucial parameter in the design of the optimal mitigation policy (unit damages are much greater than usually assumed, in which case ethical parameters matter less); 2) the distribution of damages across income groups is equally important over the range of sensible assumptions; 3) in particular, the distribution of damage that are less proportional – poor bear larger burden than their share of income – will lead to stronger mitigation policy. The latter two points indicate that the distribution of damage with respect to income is an important field for future research.

P-3322-04

City Sustainability Risk under Climate Change: A Strategic Scan Methodology

K. Doust (1) ; J. Lam (1) ; C. Wang (1) ; T. Doust (2)
(1) University of NSW, Research Centre for Integrated Transport Innovation (rCITI), Sydney, NSW, Australia; (2) Windana Research Pty Ltd, Research, Sydney, Australia

Revisiting the 2011 Climate Change and Cities First Assessment Report by UCCRN and the need to understand climate risk at the city level and infrastructure sectors, the paper discusses transport system vulnerability in both car based and public transport based modes, bringing into play the vulnerability of different parts of the transport networks. The paper also discusses the comparisons between transport networks when faced with climate change related hazards. Transport networks are designed to have an operational performance level, and are expected to contribute to a city’s overall sustainability. However, under climate change related hazards, the transport system is at risk of being in a failed state, either below its expected operational performance level or available at all. The paper introduces the types of failed states for different modes and considers how the vulnerabilities can be better understood by first understanding the effect on reliability and accessibility of severe climate change impacts. The latter can be viewed as an outcome of unsustainable practices in our built environment, infrastructure and use of resources. Sustainability itself is therefore a key contributor to mitigation of climate change hazards, but conversely climate change hazards put at risk the sustainability improvement we strive for in our cities. The paper explores measuring the vulnerability to climate change hazards, in terms of their effects on sustainability performance when the transport system suffers loss in reliability or availability. A methodology which allows for the accessibility as a useful measure in social and economic aspects of sustainability, generates scores of the vulnerability of the city based on the concept of a sustainability goal in environmental sustainability – accessibility space. A city’s sustainability performance in relation to the goal is generated using plots of environmental sustainability & accessibility for each travel zone pair in the city. A collective plot of sustainability measures for individual zonal pairs creates a simple, but analytically rich visualisation, giving insight into the position, spread and internal distribution trends for a city’s urban sustainability pillars of environmental stewardship, social equity and economic efficiency. For decision makers and policy makers the visual differences can allow the decision makers to the model outcomes and design system scenarios to be made. By including scenarios that include the transport system failed states, inclusive of the impacts of climate change hazards on travel time reliability and service availability, the paper explores the effects on the sustainability performance using the methodology. A particular strength is that the metrics are derived from data sets more likely to be found amongst transport and city planning departments. The paper presents Sydney case study visualisations to illustrate the type of high level outputs that can be built from this systems approach, to discern the merits of different resilience scenarios. With this methodology and the assistance of readily available GIS/T software, the sustainability metrics are able to be translated into spatial visualisations, to enable designing strategies of sustainability, for resilience within the city. These metrics can also be applied in a way that expresses sustainability performance in terms of a sustainability risk ranking. High risk, where sustainability performance is poor, is levelled by low. Low risk, where sustainability performance is satisfactory, is indicated by a higher metric value, above a community accepted minimum target. A grid concept likened to a risk map can be formulated, where each cell is assigned a sustainability risk rating. The sustainability risk boundaries are specific to each city, and influenced by the population’s estimated resilience. The paper discusses the technique of the translating this into a visual graphic in geographic space using geographic information system (GIS) thematic mapping. Visualisations of this type can be used to inform decision makers (community & government agencies) in the process of choosing climate change mitigation policies and programs for a city. The paper concludes with a discussion of next steps and need to further case study this work in conjunction with the greater initial selection of cities and their governments/ agencies.

P-3322-05

A Research on the Multi-country-sector Economic Growth and Global Governance of Carbon Emissions under Global Carbon Taxes

G. Gu (1) ; Z. Wang (2)
(1) East China Normal University, Population Research Institute, Shanghai, China; (2) Institute of Policy and Management, Chinese Academy of Sciences, Beijing, China

This paper focuses on the national/sectoral levels, using a climate-economic integrated assessment model namely CIECC to have an estimation of the multi-country-sector economic growth and carbon emissions under different global carbon tax rates and tax distribution schemes. The results indicate that carbon tax policies have obvious promoting effects on the carbon...
A bottom-up approach to improve local-scale understanding and decision making in responding to climate change

A. Jakeman (1) ; S. Elsawah, (1) ; J. Guillaume, (2) ; T. Filatova, (3)
(1) Australian National University, iCAM, Fenner School of Environment and Society, Canberra, Australia; (2) Aalto University, Water and development research group, Espoo, Finland; (3) University of Twente, Centre for studies of technology and sustainable development, Enschede, Netherlands

Integrated assessment models of global change require improvements to better quantify climate change impacts and to represent the effects of adaptation decisions at local scales. This is especially relevant for understanding the consequences of local decision making on land use change processes, which varies significantly across cases. Assessment of realistic adaptation options to climate change at local scales also requires recognition of institutional, governance and behavioural aspects in any modelling and analysis rather than making over-simplified assumptions such as relying solely on profit maximization. Methodologically, there is also a challenge of studying the paths people live through the continuum between collecting (often qualitative) data on local stakeholders’ decisions and tracing the cumulative impacts of those local decisions in simulation models (often quite formal and quantitative). This presentation provides an overview of model-based ways to incorporate essential human elements in decision making processes for modelling of complex socio-ecological systems, and hence improve understanding and communication about decision making in complex socio-ecological systems. The presentation then specifically tackles the challenge of bridging the qualitative and quantitative by presenting a step-wise methodology for integrating perceptions of stakeholders (qualitative) into formal simulation models (quantitative). The methodology integrates cognitive mapping and agent based modelling. It cascades through a structured, qualitative/soft and numerical method comprising: (1) Interviews to elicit mental models; (2) Cognitive maps to represent and analyse individual and group mental models; (3) Time-sequence diagrams to chronologically structure the decision-making process; (4) Building an all-encompassing conceptual model of decision making, and (5) A computational, in this case agent-based model. We apply the proposed methodology (integrated ICT) in a case study of viticulture in South Australia, which faces the potential of aggravated water scarcity under a changing climate. In particular, we focus on local decision-making under the uncertainty of low and high climate scenario (FE1) levels with respect to their understanding of risk of water shortage and chosen adaptation strategies. Finally, we use the strengths–weakness–opportunities–threats (SWOT) analysis on the methodology. Results show that the methodology leverages the use of cognitive mapping to capture the richness of decision making and mental models, and provides a combination of divergent and convergent analysis methods, deepening the understanding of decision making during the construction of an Agent Based Model.

Assessing future energy and climate pathways in an uncertain World: stochastic and parametric framework in TIMES models

A. Kanudia (1) ; M. Labriet (2)
(1) KanORS-EMR, NOIDA, UP, India; (2) Eneris Environment Energy Consultants, Madrid, Spain

Uncertainty introduces a new dimension in the decision making environment that simply cannot be captured by scenario analysis. Hedging strategy is not necessarily a combination of deterministic solutions; new options may emerge dominant with explicit treatment of uncertainty. For example, perfect foresight of no emission abatement may favor coal, and that of severe emission abatement may favor renewable sources, for near term power sector investments. However, under a stochastic cumulative emission bound, gas may become the most appealing solution for decision-makers, as it is relatively short-lived, cheap and not as polluting as coal. We see several examples of this dynamic in the runs that we propose to present.

Further, it is not easy for decision makers to assign probabilities to long term future development levels or growth rates, etc. in the simulations of four international policies because of their low abatement potentials caused by high initial low-carbon technologies, lower economic growth rates, etc. In the simulations of four international carbon tax distribution schemes, the equality principle was used on the population benefits China mostly while the carbon emission per capita principle and the payment ability principle benefit countries with large populations and low economic developments e.g. middle & low developing countries. The study shows that the knowledge capital for improving process technology progress will increase the carbon abatements, especially in developing countries. While the investing rate of knowledge capital from carbon tax return reaches up to 50%, the accumulative carbon emissions of China and India from 2016 to 2100 will be reduced by 69.27GtC and 57.78GtC separately. However, the developing countries have relatively lower emission reductions because of their higher initial capital knowledge levels, lower carbon tax returns, etc.

2030 Climate Targets in Sweden: An Integrated BU and TD Approach

A. Krook-Riekkola (1) ; B. Charlotte (2) ; E. Ahlgren (3) ; P. Söderholm (4)
(1) Luleå University of Technology, Department of Engineering Sciences and Mathematics, Luleå, Sweden; (2) National Institute Of Economic Research, Environmental economics research division, Box 3116, 103 62 Stockholm, Sweden; (3) Chalmers University of Technology, Division of energy technology, dep. of energy and environment, SE-412 96 Gothenburg, Sweden; (4) Luleå University of Technology, Economics unit, Luleå, Sweden

The aim of this paper is to identify the role of biomass in meeting stringent Swedish climate targets in the year 2030. This is achieved by improving the existing soft–linking between TIMES and PLEXOS. TIMES is an energy system model, while the TD model is an economics and EMEC (national CGe model), with special emphasis on the representation of biomass in the two models. While the generation of electricity and heat is close to carbon-free, the Swedish industry sector and transportation has remained carbon-intensive. Biomass can play an important role in meeting these targets.
role for CO2 reductions both in the industry sector (e.g. the iron and steel industry) and for transportation (e.g. biofuels). Some estimates indicate that the already high use of biomass for energy could double and still be ecologically sustainable (Börjesson et al., 2008), however, biomass will never be an unlimited resource.

The question is where, and to what extent, biomass can be used in an ecologically and economically sustainable way. The effort is to find out how this biomass can be assessed with a national energy system model covering the entire energy system, such as TIMES-Sweden. Moreover, the development of the industry sector (i.e. the demand for energy related goods and services) will both depend on future energy prices and on the remaining economy. Those aspects are those that could be assessed by a soft-link between TIMES with a national CGe model such as EMEC. A soft-link between two models has been established (see Krook–Riekkola et al., 2013). A detailed soft-link process, i.e. providing feed-back between the two models on a disaggregated level, was made possible by EMEC having a more detailed description of the energy use compared with many other CGe models. Nevertheless, CGe models are in general based on aggregated historical and current economic flows, which make it challenging to consider new fuels or technologies, such as different kinds of biofuels. In this present study, EMEC (the CGe model) have been modified to also capture the competition between traditional energy services and the new ones which facilitate an improved feed-back between the two models and in the end an improved cost analysis of potential national Swedish climate targets. The soft-link model included feed-back from TIMES-Sweden with different kinds of biomass use, including both energy intensities and cost figures, to the EMEC model. TIMES-Sweden has been improved accordingly. Furthermore, a soft-link between the two models shows that biomass play an important role in meeting tough Swedish climate targets. Biomass, used efficiently, can reduce the cost of meeting a national climate target and still be within an ecologically sustainable level of biomass harvesting.

References:

P-3322-09

A household perspective on ecosystem services: a network approach
A. Tironi-Silva (1) ; LE. Delgado, (1) ; V. Marin, (2) 
(1) Fundación CTFC, Santiago, RM, Chile; (2) Universidad de Chile, Departamento de ciencias ecológicas, facultad de ciencias, Santiago, Chile

Addressing global climate change (GCC) is one of the major social, political and economic challenges of humanity for the next decades. Scientific evidence suggests that this process already started a few years ago and will last for hundred and even thousands of years, with a scientific consensus on the changes this global phenomenon will imply on the natural and human systems. However, there still is uncertainty about the magnitude of their impacts, especially in terms of ecosystem services and social welfare, as these depend ultimately on our use of local-regional landscapes. In Latin America and the Caribbean, millions of people depend, to one degree or another, on ecosystem services because much of their well-being and production system relate to live in diverse and healthy ecosystems. Therefore, it is important to understand the relationships between natural and social systems to be able to understand the eco–social impacts of global climate change. This project aims to map, using an innovative network approaches, complex networks, natural and social capital in rural populations. These eco–social networks will be built at the household level using trans–disciplinary tools such as application and analysis of socio–ecological surveys, development of conceptual eco–social models and the development and application of network models and metrics (quantitative analysis). The project has been developed in two watersheds in southern Chile, as a case study. We already have more than 370 surveys of use of ecosystem services in rural households. Our approach tries to use complex network theory to construct a “map” of the use or demand of ecosystem services (natural capital).

Our current approach is to develop quantitative, star–shaped networks of surveyed services (wood & water usage, water treatment, hopefully recreation) with households as the center node. We’ll also try to map the social interactions that these local networks (committees, associations, subsidies, etc.) trying to find relationships between these two forms of capital. In our social capital networks, the household is also the center node of a larger shaped network composed of social capital “bridge” relationships –water committees, unions, neighborhood councils, government subsidies. Our results show different patterns of natural capital depending on the level of urbanization of each watershed. Those localities located on more natural landscapes showed a higher diversity and uniqueness of patterns of ecosystem services. Our method provides an inexpensive, flexible tool to assess ecosystem services demand at household level.

Further developments could include coupling of these networks of natural capital to biophysical models to include the offer of services from ecosystems, thus mapping the whole dynamics of ecosystem services, from offer to demand. We need to improve our knowledge of the dependencies of our wellbeing with natural ecosystems to build resilient neighborhoods and prepare our societies to adapt for an increasingly ‘uncomfortable’ planet.

The regional macroeconomic effects of delayed action in meeting a global 2 degree climate target
M. Winning (1) ; C. McGlade (1) ; J. Glynn (2)
(1) University College London, Energy Institute, London, United Kingdom; (2) UCC, Cork, Ireland

The UN Framework Convention on Climate Change (UNFCCC) negotiations have previously sought to reach a global agreement on how to limit climate change to 2°C. Despite progress over the past decades, and whilst nearly all countries have signed up to this 2°C threshold, no such comprehensive framework has yet been agreed. Whilst there is renewed focus for the COP21 negotiations to be held in Paris in 2015, the possibility still remains that there will be further delays in achieving a global agreement to limit warming to 2°C will result in increased costs for different nations.

Part of the reason for these successive failures, and a key concern for each party at the international climate negotiations in 2015, is the anticipated national economic effects of implementing ambitious climate mitigation targets that are consistent with the pledged agreement to limit climate change to 2°C. However, further delays will tend to only exacerbate these issues. The aim of this work is to use hybrid modelling techniques to determine the economic effects on regional economies of limiting global warming to 2°C. We also aim to explore the macroeconomic implications of the delays that have already occurred in reaching and implementing a global agreement, and how these will be amplified if there is further delay.

We use the TIAM–UCL energy systems model developed at University College London which is a global bottom–up technology–rich computable general equilibrium model based upon the ETSAP–TIAM model (Loulou and Labriet, 2007) but with several significant additions in terms of a climate module, a separate UK region and significant regional resource data improvements. The model has recently been applied to explore distributional effects of unused fossil fuels in meeting a 2°C target (McGlade and Ekins, 2013). Here, we expand upon the model by considering the potential real–world effects of potential regional GDP loss of limiting climate change to the agreed 2°C threshold.

We have added a simplified general equilibrium macroeconomic growth module developed by Kypreos and Lehtila (2013). The model is a single agent, single sector, multi-regional, general equilibrium optimal growth model which maximises discounted utility of a single consumer–producer agent. GDP is comprised of consumption, investment and energy system costs. Total
emission strategy in the future process of climate change. The model is widely used in the research team for regional climate. Considering the CO2 emission are also uncertain. the energy peak year will be examined in this work. By examining which thus make the emissions reduction more difficult to achieve, will be investigated in this work. The efficiency and usefulness of this method are then propose a so-called fitted finite volume method to solve it. The simulation error, and improve the reliability of innovation. Then we will consider the future climate change trend of China in the middle 21st century, under the A1B scenario. As results show, the multiyear average temperature increases more in the north region than that in the south, more in the east then it in the west. The increase ranges from 1.5°C in the southeast to 2.4°C in the northwest, even reaches to 3°C in some area.

The contemporary climate simulation results in 1981–2000 are subtracted form the A1B scenario simulation prediction results in 2041–2060 respectively. In this way, we reduce the uncertainty in climate predictions brought by the simulation error, and improve the reliability of innovation. Then we will consider the future climate change trend of China in the middle 21st century, under the A1B scenario. As results show, the multiyear average temperature increases more in the north region than that in the south, more in the east then it in the west. The increase ranges from 1.5°C in the southeast to 2.4°C in the northwest, even reaches to 3°C in some area. Different from mean temperature, the variation trend of multiyear averaged annual precipitation does not show an increasing trend in all regions. The annual precipitation may have a decrease in the middle and northeast Tibetan Plateau, including the yangtze–huaihe region, which generally reduces about 100 mm. The average annual precipitation decreases more in the southeast than it in the southwest, and it decreases over 200 mm in some area. The precipitation may be lower in Guizhou and east Yunnan, as well as the east and north region of Taiwan. However, an increasing trend of annual average precipitation can be seen in the northwest region of China, especially in east Inner Mongolia and local area of Helongjiang. In addition, there is a sharp increase in south Tibetan Plateau, which may exceed 200mm.

A lot of researches on climate change simulation are reported, and the simulation of RegCM4 under A1B scenario is accepted by most scholars now. While some details of this simulation results differ from others results, the error is acceptable. A1B scenario simulation data produced by global circulation model ECHAM is chosen and used as the driver of regional climate model initial field and the lateral boundary conditions. Its change rate of annual average temperature is close to observed value and the performance of the seasonal and interannual variability of precipitation is reasonable. Simulation period begins on 15 October 2040 and ends to 31 December 2060 and the period before 31 December 2040 is seen as simulation initialization phase. The surface temperature boundary field comes from SST_A1B data on RegCM4 website, interpolated on the grid simulation area.

The contemporary climate simulation results in 1981–2000 are subtracted form the A1B scenario simulation prediction results in 2041–2060 respectively. In this way, we reduce the uncertainty in climate predictions brought by the simulation error, and improve the reliability of innovation. Then we will consider the future climate change trend of China in the middle 21st century, under the A1B scenario. As results show, the multiyear average temperature increases more in the north region than that in the south, more in the east then it in the west. The increase ranges from 1.5°C in the southeast to 2.4°C in the northwest, even reaches to 3°C in some area. Different from mean temperature, the variation trend of multiyear averaged annual precipitation does not show an increasing trend in all regions. The annual precipitation may have a decrease in the middle and northeast Tibetan Plateau, including the yangtze–huaihe region, which generally reduces about 100 mm. The average annual precipitation decreases more in the southeast than it in the southwest, and it decreases over 200 mm in some area. The precipitation may be lower in Guizhou and east Yunnan, as well as the east and north region of Taiwan. However, an increasing trend of annual average precipitation can be seen in the northwest region of China, especially in east Inner Mongolia and local area of Helongjiang. In addition, there is a sharp increase in south Tibetan Plateau, which may exceed 200mm.
Human Dignity & the Future of International Environmental Governance in the light of ICJ Jurisprudence: A Normative Analysis

K. Bansal (1)
(1) International Policy Analysis Network (IPAN), Karnal, Haryana, France

More than being an attempt to suggest a direction for the further policy discourse, this paper presents a normative perspective which espouses and analyses Human Dignity as a School of Law with regards to International Environmental Governance.

The paper begins with an introduction of Human Dignity as the foundation of modern public international law and explains it further in the light of Elementary Consideration of Humanity doctrine as developed by the International Court of Justice (ICJ). This part explains the irreversible connection between the contemporary principles of international environmental governance and human dignity by relying upon various legal authorities and opinions.

The second part of the paper brings out the deficits of international environment law. It is argued that in the light of the conceptual trinity of sources of international law as enshrined in Article 38 (1)(c) of the ICJ Statute, one may observe that the deficit of international environment law is trilateral: treaty law, customary rules and the general principles of international law.

In the third part, this paper comprehensively analyses international environmental jurisprudence as developed by the International Court of Justice in order to address the deficits in the law as pointed out in the second part of the paper. It is argued that the ICJ’s environmental jurisprudence reflects that progress in the international environment law can well be secured by the application of general principles of international law. Here, relying upon the ICJ jurisprudence, four such core principles are also identified which provide the basis for an environment specific legal application.

The objective of this paper is two-fold: firstly, to take forward the discourse on the future of global governance norms in the light of human dignity as the core principle, especially with regards to environmental governance; secondly, to propose the fundamental principles through a normative analysis which should form the cornerstones of the broader discussion taking place during the conference.

Justice and equity in REDD+

A. Wardell (1)
(1) CIFOR, Montpellier, France

The UNFCCC adopted Reducing Emissions from Deforestation and Degradation, enhancement of carbon stocks, conservation, and sustainable management of forests in developing countries (REDD+) as a climate mitigation mechanism given the scale of CO2 emissions resulting from the conversion and degradation of tropical forests (ca. 12–15% of global anthropogenic greenhouse gas emissions (GHG)), and the early belief that avoiding deforestation would be a ‘quick, cheap and easy’ mitigation option. REDD+ was originally conceived as a system of Payment for Environmental Services which aimed to link sellers and buyers via voluntary, conditional agreements over a well-defined environmental service – or a land use presumed to produce that service. The majority of funding, it was anticipated, would come from carbon markets.

Despite the significant technical, methodological and policy challenges that still need to be met, it is likely that REDD+ will be a component of a new climate change agreement given the Copenhagen Accord, the outcomes of the work on REDD+ safeguards of the AWG-LCA in Cancun, the Warsaw REDD+ Framework, the ADP’s continuing efforts to address Non-Carbon Benefits, now project-based approaches and joint mitigation and adaptation, and the emergence of a plethora of project-based and jurisdictional REDD+ standards. This despite the effective collapse of (forests) carbon markets, and an overall negative performance at a global scale (GHG emissions in 2012 were at 58% higher levels than they were in 1990 cf. Article 2 of the Convention). REDD+ activities are now financed predominantly as part of Official Development Assistance programmes. The added incentives promised by REDD+ are likely to heighten the existing struggles for access to, and control over land and forest resources. As new values are assigned to forests, contestation between statutory and customary systems of individual and communal property regimes is likely to be exacerbated.

This paper adopts a ‘rights, responsibilities, revenues and relationships’ framework to highlight the (relatively) limited attention accorded, to date, to develop appropriate legal frameworks for REDD+ often in contexts distinguished by legal pluralism and multiple framings and dimensions (procedural, distributive and contextual) of ‘justice’ and ‘equity’ at different scales of governance. It raises questions (again) about the limits of blueprint development that often privileges external actors (and their knowledge systems) over local communities. Complex legal issues such as those related to land tenure, benefit sharing, constitutional boundaries of local autonomy, and liabilities have not been adequately addressed to provide enabling legal frameworks for REDD+ implementation. The paper draws on collaborative research conducted by CIFOR and IDILO in Tanzania, Mozambique and Zambia.

Law and Governance Instruments for Sustainable Landscapes in the Low-Carbon Economy

MC. Cordonier Segger (1) ; A. Wardell (2) ; G. Markus (3)
(1) CISDL – Centre for International Sustainable Development Law (CISDL), c/o LCIL, University of Cambridge, Cambridge, United Kingdom; (2) CIFOR, Research capacity and partnership development, Montpellier, France; (3) LCIL, Faculty of Law, University of Cambridge , Cambridge, United Kingdom

Sustainable development of landscapes requires multi-sectoral and multi-level interventions, in order to deliver on the potential opportunities of the low-carbon green economy. What international law and governance instruments and mechanisms, legal and customary, are assigned to forests, contestation between statutory and customary systems of individual and communal property regimes, particularly in forest, agriculture, extractives and other sectors, to promote more sustainable trade and investments? New governance research and legal analysis is focusing on the innovative international economic instruments that global treaty processes, such as the UN Framework Convention on Climate Change, offer to provide incentives towards more sustainable landscapes.

At the same time, while the Doha Development Agenda remains stalled in the WTO, emerging regional trade and investment treaty measures are seeking to encourage sustainable development of renewable energy, forests and other resources. These international regimes, and the financial flows that they govern, might serve to frustrate more sustainable development, requiring robust application of social and environmental safeguards. Or, if implemented in an effective and integrated manner, they may hold the potential to foster more sustainable development on the ground and across transnational value chains, providing levers for countries to ensure better governance of scarce natural resources in these value chains and improve our capacity to respond to climate change mitigation, resilience and financing challenges. Based on recent books and multi-country climate law and governance studies, this paper explores the key interrelationships of legal frameworks, institutions and regulatory innovations, world-wide, and considers how can recent emerging treaty-based regimes and instruments contribute to sustainable landscapes governance.
Migration, environment and climate change: legal frameworks and challenges

D. Mokhnacheva (1), A. Sironi (1)
(1) International Organization for Migration, DMM/MECC, Paris, France

The issue of a legal framework to address environmental migration is a widely debated topic. There is no internationally accepted legal definition or specific status for people on the move due to environmental factors, and no legal instrument dedicated specifically to this issue. As a result, ensuring the protection of affected individuals seems challenging in the absence of one instrument that identifies the applicable rights and corresponding States obligations tailored to the specificity of environmental migration. This has led to strong calls for international efforts to create a specific legal status for environmental migrants.

This presentation will provide an overview of the particular challenges environmental migrants may face in terms of human rights and justice; existing legal instruments, their applicability in the context of environmental migration, as well as their limitations; and discuss the prospects and challenges for creating a protection framework for those displaced by climate change. As the leading migration agency, IOM will share its practical experience and emphasize the importance of a rights-based approach to the management of environmental migration.

Hybrid Legal Approaches towards Climate Change: Concepts, Mechanisms and Implementation

C. Corendea (1)
(1) United Nations University Institute for Environment and Human Security (UNU–EHS), Environment, Migration, Social Vulnerability and Adaptation (EMVSA), Bonn, NRW, Germany

In the light of better understanding global risks, this paper will explore environmental risks from a climate change legal–related perspective, in particular human rights and migration, focusing on the core of the problem and not essentially on the form, drawing on and using regional level experiences, such as Pacific Islands. The paper will address climate change triggers, such as sea-level rise impact on national and regional law upscaling to international law, for considering a potential legal approach, not just in terms of mitigation, but also in terms of adaptation, risk reduction, transfer of technologies, climate finance and capacity building.

Hybrid approach is based on the (International) Hybrid Law, a legal research tool which concurrently, indivisibly and interrelated analyse a climate change case study from three perspectives: environmental law, human rights and refugee (migration) law. Hence, the research is simplified, using a single lens as a replacement for a three way analysis.

It was noted that having the main cause in breaching international environmental law, e.g. violation of the principles of international environmental law, the main legal effects are mostly to be found in the human rights law, due to its unavoidable first impact upon the targeted society. Secondary, as a subsidiary effect, there is refugee (migration) law, because of the same strong impact, regardless of the type of response: immediate, intermediate or long-term.

There are two methodologies the research will make use of in regards to address the issues mentioned above:

- Rights–based approach which will emphasise the bottom–up standpoint as imperative in the post–2015 climate agreement (human oriented analyses, loss and damage, etc.)

And

- The progressive interpretation of law methodology which will underline the need of hybrid approaches in addressing climate change from a legal perspective in particular in relation to human rights (direct effect) and migration (as subsidiary effect).

The paper applies international hybrid law methodology in its innovative endeavor to address the challenging questions of the existing legal gaps in international law, environmental (legal) risks and human security in an unprecedented global circumstance, when States, for the first time in the history of the humankind, are projected to disappear from the world map without war.

Exporting Harm

J. Moss (1)
(1) Practical Justice Institute, Social Sciences, Sydney, Australia

In this paper I will discuss an aspect of the problem of how to divide the World’s remaining ‘carbon budget’ – the amount of CO2-e that can be emitted if we are to avoid dangerous climate change. I will argue that there is a prima facie case for allocating responsibility for the harms caused by exported emissions such as those produced by coal, as well as those that are produced within a country’s borders. This is not a complete determination of the carbon budget problem by any means, but a step towards its development.

My paper sets out some of the factors that determine a country’s carbon budget and argues that the current methods for allocating emissions and responsibilities for their harms are inadequate and more complex than they appear.

The paper will consider several dimensions of the harm caused by unrestricted fossil fuel exports. First, what kind of harm is caused by such exports? Second, whether analogies exist between other harmful exports – medical waste, tobacco, unsafe jobs, uranium – and fossil fuels to examine how the kind of harm caused by global warming is different from standard cases of harm where only two parties are involved. Third, whether unrestricted export of fossil fuel exports satisfy a ‘fair shares’ criterion. Finally, what allocating responsibility for harms means in practice.

Environment Tribunals and Justice: The Indian Experience

R. Brara (1)
(1) University of Delhi, India, Department of Sociology, Delhi, India

I inquire into practices and experiences with adjudication that emerge from a study of the cases filed before the newly formed National Green Tribunal in India and interviews with selected lawyers and appellants that focus on governance and justice. My endeavour is to show how the affected public’s vulnerability to environmental and climate change intersects with the discourse and practice of governance, ethics and justice as well as resilience, mitigation and adaptation.

Taking a bird’s eye-view, collective experiences of vulnerability have given rise to the organization of multiple environmental publics in India. Analyzing the cases filed before the National Green Tribunal by these publics enables me to demonstrate that by litigating the environmental public interest, the experience of vulnerabilities is often
transformed into events marked by resilience though not necessarily by success.

From a local perspective, issues of scale and change and the environment cannot be easily disentangled since climate change hits the environment as base. It is a local–cum–environmental violation that comes to threaten the life of an individual or household and is articulated as worthy of further action by gathering a public and acquiring a strategic local scale. The next step begins with the search for an environmental lawyer (and funds) for adjudication before the Tribunal. This step is the event’s translation into the language of law and the state, which produces and views the violation from an altered scale and perspective. The transformation is experienced as a rupture that marks the distance from a local public to a public mediated by the environmental laws of the state.

New interactions then occur across scales such that the environmental/ climate cause lawyer assumes a critical role with the face off local as it were, and the other to the law as its representative interpreter. The environmental lawyer addresses the mismatches between the scale of law and the local apprehension of the problem and scale as he sifts the facts and frames them for presentation in a legal case. What comes into being at the local level, then, is a heightened awareness, friction and even a revelation, of the limits of legal processes (spatially, temporally and including their possibilities for justice). Simultaneously, therefore parallel channels of communication are activated and engaged to reach out to politicians and government officials at multiple sites in the quest for justice.

The Legal Bench of the Tribunal embodies the statutory perspective even more completely than the lawyer. Here the facts of the case are readily rendered as background and the legal order of argumentation and knowledge, into which the case must fit, takes precedence. From this perspective, the judge or Bench often reads the environmental violation as an issue that stems from the inadequacy of the executive which has failed to do its jobs and let the problem fester. As the legal judgment, in its corrective mode, travels back to the local, it is inevitably filtered through the visions of the executive such that the local enforcement of a judgment on the ground is rendered uncertain and risky. The implementation of a sound legal judgment is contingent on the local bureaucracy and the local public attempts to adapt to this maladapted reality.

The global of environmental law and governance also emerges as a producer of new scales and perspectives from a different situated context. The transnational environmental climate sphere’s scales and processes, too, journey downwards to nation–states where these are both ratified and refracted. The judge who embodies the statutory perspective of the nation state also appears as the arbiter of national difference from promulgated global principles of environmental–cum–climate regulation. International treaties are thus unable to trump national sovereignty in the present.

What you have, then, is an insubordination of scales, compelling us to move up, down and sideways to understand and address the legitimacies/ illegitimacies of governance and justice and the frictions of local and national difference in the context of environmental change.

P-3323-02
Governance of Local Disaster Management Committees in line with SOD in Bangladesh
SA. Siddiquee (1)
(1) WAVE Foundation, Monitoring and Evaluation, Dhaka, Bangladesh

Due to its geographical location Bangladesh has always been prone to natural disasters such as tropical cyclones, floods, droughts, tidal surges, tornadoes, river–bank erosion and many more. Bangladesh has shown significant improvement in disaster management which is proven by the possession of Standing Orders on Disaster (SOD), Disaster Management Act, National Disaster Management Plan, Disaster Management Policy, Disaster Management Committees at the District, Upazila and Union levels. However, despite the government’s effort given by many actors the room for improvement prevails in the disaster management system. A total of 51 DMCs in five districts that were vulnerable to floods, river–bank erosion, drought and cyclone were taken as sample to analyse the current situation of these committees. The study was conducted using both qualitative and quantitative methods. Both open–ended and close–ended questions were asked. Questionnaire and KII tools were used to collect information from respondents in both the government organizations and NGOs. The study has observed poor coordination between GO and NGOs at the sub–national and local level. Surprisingly, the study has found that only 38.9% DMC members are informed about Disaster Management Act and 36.76% are aware about their roles and responsibilities in the Standing Orders on Disaster (SOD). Although the selected districts are extremely prone to disasters, surprisingly it has been observed that 70% of DDMCs and 30% of U2DMCs are holding regular meetings and only 16.22% of UDMCs are holding regular meetings as per the SOD. The scenario mentioned above clearly states that the DMCs are not active as they should have been according to the SOD. Only 43% of DMCs have Risk Reduction Action Plan (RRAP) but perform very few activities according to the RRAP. It was found that only 23.3% of DMCs have developed volunteer groups and only 26% of DMCs have arranged community awareness building programmes. The study has also found that only 34% of Union Parishads have incorporated DRR into their Annual Development Plan. It is alarming that even though Bangladesh is one of the prime victims of climate change, encountering severe and frequent disasters like Sidr, Aila and Mahasen, 66% of the sample Union Parishads did not have DRR integrated into their ADPs. Based on the gaps recognized in the study, it can be concluded that the functionality of the DMCs needs to be improved through capacity building, training, and materials such as a guidebook to simplify the SOD etc. in order to leverage the current Disaster Management System. Engineering the DMCs to be more effective and understanding in Information Technology and by linking them to the national level will ultimately lead to more and improved governance system of Disaster Management Committees.

3324 - Paradigms for Building Resilience from Cross-scale Integrated Risk Governance Perspectives

O-3324-01
Risk Culture: Implications for Risk Governance
O. Renn (1); E. Boyd (2)
(1) University of Stuttgart, The economic and social sciences, (2) University of Reading / Stockholm Resilience Centre, Department of Geography and Environmental Science, Reading, United Kingdom

Deciding about the location of hazardous facilities, setting standards for chemicals, making decisions about cleanups of contaminated land, regulating food and drugs, as well as designing and enforcing safety limits all have one element in common; these activities are collective endeavours to understand, assess and handle risks to human health and the environment. These attempts are based on two requirements. On the one hand, risk managers need sufficient knowledge about the potential impacts of the risk sources and the likelihood of different decision options to control these risks. On the other hand, they need criteria to judge the desirability or undesirability of these consequences for the social order as a whole. This second part is an integral aspect of risk culture, understood as the systems of norms, values and visions that an organization shares among its members. Within the portfolio of organizational culture, criteria on desirability are reflections of social values such as good health, equity,
or efficient use of scarce resources. Both components - knowledge and values - are necessary for any decision-making process independent of the issue and the problem context.

Anticipating consequences of human actions or events (knowledge) and evaluating the desirability and moral quality of these consequences (values) pose particular problems if the consequences are complex and uncertain and values are controversial and controverted. Dealing with complex, uncertain and ambiguous outcomes often leads to the emergence of social conflict. This is particularly the case for emerging technologies where the risks are not yet known and it is often impossible to agree on the overall goal of safety and environmental quality. Precisely what that goal entails (how safe is safe enough?) and precisely how that goal will be obtained may evoke substantial differences between the stakeholders. How can the most suitable criteria for judging risks? How can an organizational culture cope with uncertain outcomes and how can it develop an effective monitoring system. How should an organization manage risks that benefit one party at the expense of potential harm to another?

These crucial questions of how to deal with complex, uncertain and controversial risks demand procedures of decision-making that go beyond the conventional risk management routines. Numerous strategies to cope with this challenge have evolved over time. They include technocratic decision-making through the explicit involvement of technical experts, institutional arrangements for foresight and monitoring, direct stakeholder involvement, and external reviews. The argument of the paper is that public and private institutions that assess and manage risks are in urgent need of revising their institutional routines and of designing procedures that enable them to integrate professional assets, such as extending expert (systematic knowledge), adequate institutional process (organizational culture), responsible handling of public resources (efficiency) and stakeholder knowledge and perceptions (reflection on public values and preferences). These various inputs require the inclusion of multiple procedures and the involvement of several actors in the risk assessment and risk management process. The structures and the evolution of the various actors and phases of the risk handling process are subsumed under the term risk governance. Governing choices in modern societies is seen as interplay between governmental institutions, economic forces and civil society actors, such as non-governmental organizations (NGOs). ‘Risk governance’ involves the ‘translation of the substance and core principles’ to governance of the context of risk and risk-related decision-making. It includes, but also extends beyond, the three conventionally recognized elements of risk analysis (risk assessment, risk management, and risk communication). It requires consideration of the legal, institutional, social and economic contexts in which a risk is evaluated, and involvement of the stakeholders who represent them. Risk governance looks at the complex web rules, conventions, processes, and mechanisms that are relevant to how relevant risk information is collected, analysed and communicated, and how management decisions are taken. Such an approach links risk governance with risk culture. O-3324-02

Disasters and Green Growth: An Exercise in Complexity

C. Jaeger (1)
(1) Global Climate Forum, Berlin, Germany

It is by now common knowledge that air pollution is a huge disaster in Beijing as in other megacities of the present. It is less known that a century ago air pollution was at least as disastrous in Chicago and other large cities of those times. While efforts to reduce those historical pollution disasters have already taken place throughout the United States and other countries, we are now facing a new, almost entirely unexplored problem – the complex and controversial phenomenon of air pollution control, a phenomenon that has evolved into an exercise in complexity.

The paper utilizes the tendency value and fluctuation value of temperature and precipitation from 1961 to 2010 to identify the climate change quantitatively, and completes the structures and procedures and the involvement of several actors in the risk assessment and risk management process. The structures and the evolution of the various actors and phases of the risk handling process are subsumed under the term risk governance. Governing choices in modern societies is seen as interplay between governmental institutions, economic forces and civil society actors, such as non-governmental organizations (NGOs). ‘Risk governance’ involves the ‘translation of the substance and core principles’ to governance of the context of risk and risk-related decision-making. It includes, but also extends beyond, the three conventionally recognized elements of risk analysis (risk assessment, risk management, and risk communication). It requires consideration of the legal, institutional, social and economic contexts in which a risk is evaluated, and involvement of the stakeholders who represent them. Risk governance looks at the complex web rules, conventions, processes, and mechanisms that are relevant to how relevant risk information is collected, analysed and communicated, and how management decisions are taken. Such an approach links risk governance with risk culture. O-3324-02

World Regionalization of Climate Change [1961–2010]

Q. Ye (1) ; P. Shi (2)
(1) Integrated Risk Governance Project, Beijing Normal University, Beijing, China; (2) Beijing Normal University, State key lab for earth surface processes and resource ecology, Beijing, China

Existing climate regionalization aims to characterize the regional differences in climate based on years of the modern environmental risks incurred from climate changes. This paper utilizes the tendency value and fluctuation value of temperature and precipitation from 1961 to 2010 to identify the climate change quantitatively, and completes the world regionalization of climate change (1961–2010) with state (province) administrative regionalization as the unit in combination with world’s terrain feature. Level-I regionalization divides world’s climate change (1961–2010) into thirteen tendency zones based on the tendency of temperature and precipitation; level-II regionalization refers to twenty-nine fluctuation regions based on level-I regionalization according to the fluctuation of temperature and precipitation.

O-3324-04

Everyday disasters, adaptation governance & resilience frameworks

A. Ghosh (1) ; E. Boyd (2)
(1) University of Heidelberg, south asia institute, Heidelberg, Germany; (2) University of Reading / Stockholm Resilience Centre, Department of Geography and Environmental Science, Reading, United Kingdom

This paper introduces the concept and consequences of ‘everyday disasters’ – when regular oceanic processes such as tidal bores and high tides become more intense and catastrophic, destroying lives of those who live in low-lying coastal areas. Another consequence under the influence of climate change, sea level rise, coastal erosion and land subsidence. In the Indian Sundarbans, world’s largest mangrove ecosystem situated at the mouth Bay of Bengal and a part of world’s largest delta, these ‘daily’ weather hazards are egregiously affecting the socio–ecological system, leading to human crises of unprecedented proportions. Not classified and defined as ‘disasters’ and thus unattended by local, national and international disaster management authorities, these events engender a socioeconomic challenge to structured adaptive governance which is yet to be studied formally or understood.

Majority of the indicators of global warming are already higher than global averages in Sundarbans. Eventual outcomes in terms of actual environmental shifts as a product of complex interactions between anthropogenic and climate changes in this socio–ecological system are making the challenge of climate change adaptation further complex, along with increased intensity and frequency of cyclones, typhoons, flash floods, which have, however, received considerable attention from disaster risk reduction scholars.

On July 12, 13 and 14, 2014, a regular oceanic phenomenon of a tidal bore devastated island villages across Indian Sundarbans, destroyed human settlements, infrastructure, dwellings and displaced about 100,000 people, forcing them into near starvation for over three months. It also destroyed prospects of agriculture and fishing for an indefinite future. Using snowball sampling, extensive qualitative interviews, photographic and audio–visual evidence were collected from five of the affected villages between July and September 2014. The findings reveal areas with striking regularity, lastly a disaster and a disparate adaptation discourse that have failed to internalise these events. Through grounded narratives and evidences, this paper elaborate how threats from environmental change is not ‘adapted’ but is passed to social ones, exacerbating the existing crisis in the socio–ecological systems; underscoring specific needs for governance processes and systems to target newly
emerging socio-environmental risks. The analysis also underscores epistemological weaknesses of existing resilience frameworks that are unable to address changing nature of vulnerabilities to livelihoods and human security. Also, imprint of the event on the adjoining areas, especially towns and cities in the region because of large human migration, argues for reconfiguring development paradigms in wake of altering environmental realities.

Thus, this work addresses two of the biggest gaps in research geography of global environmental change: the first relates to how scientific knowledge is being aggregated and the second involves the way scientific knowledge impacts governance processes and thus wider society, including policy communities. Thus, this latter question is particularly important from the perspective of governing global environmental processes such as climate change.

To address these questions we investigated two hypotheses: first, that governance performance and research and development (R&D) are related independent of national income levels. Second, that these relations differ across high-income countries and lower-income countries, both quantitatively and qualitatively. We drew on publicly available country-level statistical data from the World Bank and UNESCO to investigate how national governance capacities are related to research and development investment (R&D). Using a sample of 209 countries we show that, while national income is an important factor, governance performance is independently related to R&D. Importantly, different domains of governance are relevant for high-income and lower-income countries. In terms of governance, in high-income countries, ‘governance effectiveness’ is the sole predictor of R&D while, in lower-income countries, it is predicted by greater ‘rule of law’ but less ‘control of corruption’. These results show that the relationships between governance and R&D in lower-income countries are complex and substantially different from high-income countries. More detailed analysis is warranted if we are to understand how to address the diversity of science-governance relations and the challenges and opportunities they pose for linking knowledge with action on global issues.


O-3325a-02

Addressing migration in the context of global environmental change: an institutional perspective

M. Traore Chazalnoel (1)
(1) International Organization for Migration, DMM/MECC, Geneva, France

As the leading migration agency, the International Organization for Migration has been working on migration, environment and climate change for more than twenty years, promoting research, awareness and knowledge of the subject, contributing to mainstreaming migration and environment into policies, promoting migration as an adaptation strategy in the context of climate change, building the capacity of key stakeholders, and assisting migrants in need, by combining bottom-up and top-down approaches to the management of environmental migration.

Building on the Organization’s global research, operational, and policy experience, this session will reflect on the pathway from knowledge to action in the area of climate-related migration governance. The presentation will explore the opportunities migration offers in the context of climate change, and discuss the challenges and opportunities around addressing environmental and climate-related migration, including the difficulty of measuring and framing environmental migration and producing evidence to inform decision makers; the challenge of bridging the gap between empirical knowledge and political action; and of putting policies into practice; the difficulties behind attracting funding to enable action; legal challenges; operational and coordination challenges.

The session will also present some recommendations and possible avenues for improved action and governance of environmental migration, as a contribution to the preparatory work ahead of the COP21.
O-3325a-03

The smallholder farmers' adoption challenges on conservation agriculture practices in the southern highlands of Tanzania

B. Gwambene (1)
(1) Institute of Resource Assessment, University of Dar es Salaam, Dar es Salaam, Tanzania, United Republic of Tanzania

Conservation Agriculture (CA) used as a mitigation and adaptation option to address impacts of climate variability and an alternative practice for increasing food production while maintaining the soil resource base. It is promoted to address the problems of soil degradation resulting from the impacts of climate change and agricultural practices that deplete the organic matter and nutrient content of the soil. However, adoption of CA among smallholder farmers has been limited and features many challenges in the southern highlands of Tanzania. This paper assesses the challenges of adopting conservation agriculture practices in smallholder and subsistence farming in this region. It used the survey methods that include participatory rural appraisal (PRA), questionnaire survey, key informant interview and field observation to collect both qualitative and quantitative information. The qualitative methods established the knowledge and experience with livelihood activities, adoption of CA, spatial and temporal changes in agricultural production and response strategies while the quantitative method provided the percentages and statistical information. The qualitative data were processed and analyzed by using trend and content analysis while quantitative data were analyzed by using Microsoft Excel and SPSS software. The results indicate that about 95% of smallholder farmers tend to only adopt certain components, such as mulching, crop rotation and water management techniques. Factors such as the knowledge-intensive nature of implementing CA practices, long term crop yield benefits from CA, strong trade-offs posed adoption challenges. Poor functioning and access to the recommended inputs, markets and credit facilities and shortage of extension services increased adoption challenges at a local level. It was further revealed that climate variability, land exhaustion/shortage, unreliable markets, and lack of product knowledge were reported to increase challenge in crop production. An enabling environment for farmers through appropriate policy, strategies and implementation plans at all levels provide an opportunity to increase adoption of CA and improve their livelihoods and productivity. This will need a policy and strategies that focus more on technical approaches to increase adoption rates with the consideration of social aspects such as perceptions that are equally important in conservation agriculture. Understanding what motivates farmers to try or reject specific CA practices is imperative in adoption of technology. In practice, farmers are able, or willing, to implement or partly adopt based on their perception of what is feasible in their particular circumstances. Issues such as the nature of the technology, affordability, time and resource invested, accessibility to appropriate tools and equipment, and competition for crop residue have influenced rate and extent of adoption among smallholder farmers.

3325b - Creating the climate change groundswell by communicating business, science and regional activity

ORAL PRESENTATIONS

K-3325b-01

Academic and Business Solutions for People and the Planet

McNeely (1)
(1) Harvard School of Public Health, Center for Health and the Global Environment, Boston, MA, United States of America

Abstract not communicated

K-3325b-02

Galvanizing climate action at all levels

H. Thomas (1), B. Guy (2), T. Edwards (3)
(1) Oxford University, Blavatnik School of Government, Oxford, UK; (2) Natural Resources Defense Council, New York, USA, (3) The Stanley Foundation, Muscatine, United States of America

Abstract not communicated

K-3325b-03

Decision-Making under Climate Change: the challenge of linking science, policy and management

D. Ryan (1), D. Gorfinkeil (2)
(1) Regional Centre for Climate Change and Decision Making, Buenos Aires, Argentina, (2) UNESCO Climate Change Initiative for Latin America and the Caribbean, Unesco, Montevideo, Uruguay

Abstract not communicated

O-3325b-01

Graduated response from the stakeholders to the climate change impacts on water using a vulnerability index combining the uncertainties

T. Pelte (1)
(1) Rhone Mediterranean Corsica water agency, Lyon, France

The Rhone Mediterranean Corsica water agency and the Regional Direction in charge of the environment – the DREAL – have been engaged since 2012 in a common project for climate change adaptation. The work has developed a method to assure a solid “interface” between water policy makers and the scientific and technical fields conducting research on the impacts of climate change. Key information are provided to planners, water managers and policy makers, on the scientific knowledge that will have to be used in short- and long-term decision making for regional adaptation. The work is organized in three interacting processes: 1. the production and gathering of scientific knowledge in order to identify climate change-related phenomena that will impact water management strategies. 2. the building of maps of the Rhone-Mediterranean basin showing regional vulnerabilities to climate change from five points of view: water resources, soil water balance, biodiversity, trophic level of rivers and snow. Each map presents a vulnerability index built for a large scale approach in order to deliver the key information to stakeholders. 3. a short-list of adaptation measures is presented face to each vulnerability map. The measures are graduated according to the level of uncertainties of the vulnerability index. The exercise combines the exposition level to climate change with the sensitivity of the basin. The exposition level is delivered by climate projection results from 7 regionalization methods and 2 hydrological models. The sensitive index is built with technical characteristics of the basin linked to the issue.
Sharing local and scientific knowledge for climate change modeling. A case study from an Andalusian olive-growing region (Spain)

M. Cohen (1); J. Ronchail (2); M. Alonso-Roldán (3); S. Angles (4); E. Araque-Jimenez (5); D. Labat (6); H. Garcin (7); C. Morcel (7); B. Sultan (8)

(1) Université Paris Sorbonne, UMR Enec, Paris, France; (2) LOCean and Université Paris Diderot, Paris, France; (3) Associazione Pasos, Participación y Sostenibilidad, Órgiva, Spain; (4) Université Paris–Diderot, Sorbonne Paris Cité, Umr eneC, Paris, France; (5) Université de Jaén, Facultad de geografía, Jaen, Spain; (6) Université de Toulouse, Géosciences environnement toulouse, Toulouse, France; (7) Université Paris–Diderot, Sorbonne Paris Cité, Ufr ghss, Paris, France; (8) IRD, LOCÉAN, Paris, France

Under a research program focused on the adaptability of olive growing systems to climate change in the Sierra Mágina region of Andalusia and under the demand of a local action group, we combined an interdisciplinary approach, collaboration among climatologists, geographers and sociologists, and the participation of local farmers and stakeholders, in building the local knowledge. Sierra Mágina is a highly specialized Mediterranean agrarian territory: olive groves represent 85% of cultivated land (in 2006), half of them being irrigated. Our collaboration with local stakeholders and farmers developed to the extent that we incorporated the “local knowledge system” in our scientific and modeling process. This incorporation had two objectives: on one hand, we expected that it would promote the buy-in of our projections by local stakeholders and farmers; on the other hand, we expected that local knowledge should help us understand the relationships between olive-growing, climate variability and climate change. This last step of this process consisted in sharing our results with stakeholders and farmers developed to the extent that we incorporated the “local knowledge system” in our scientific and modeling process. This incorporation had two objectives: on one hand, we expected that it would promote the buy-in of our projections by local stakeholders and farmers; on the other hand, we expected that local knowledge should help us understand the relationships between olive-growing, climate variability and climate change. This last step of this process consisted in sharing our results with stakeholders and farmers. This exercise is an original approach which combines the bottom-up and top-down approaches that are ordinarily used to build climate change adaptation strategies. The vulnerability index is inspired by the top-down approach and the graduated response by issue is the result of a bottom-up approach connected to the stakeholders. This last step of this process will allow the project to result in stronger, more efficient messages.

This work has been lead under the authority of the Basin Committee, a governance structure that includes all stakeholder groups involved in water policies (State and local governments, urban, industrial and agricultural water users...).

The last step of this process consists in sharing our results in a seminar and in an engaging workshop, bringing together scientists, farmers and stakeholders. This process will allow the project to result in stronger, more efficient messages.

The “Soil Carbon Network for sustainable agriculture in Africa”: an open scientific group for a better consideration of CSA in Africa

TM. Razafimbelo (1); G. Amadji (2); O. Balarabe (3); YN. Badiane (4); E. Hien (5); A. Kone (6); H. Konareh (7); MH. Taiss (8); T. Gallali (9); M. Bernoux (10); A. Bilgo (11); H. Razakamanarivo (10); E. Blanchart (12); M. Brossard (10); L. Bockel (13)

(1) University of Antananarivo, Laboratoire des Radiosotopes, Antananarivo, Madagascar; (2) Université d’Abomey-Calavi, Faculté des sciences agronomiques, Cotonou, Benin; (3) Institut de Recherche Agricole pour le Développement Libreville, Cameroon; (4) Institut Sénégalais de Recherches Agricoles, Dakar, Senegal; (5) Université de Ouagadougou, Ouagadougou, Burkina Faso; (6) Nangu Abrogoua University, Ufr ghss – center for research in ecological agriculture and forest sensu lato; (7) Institut d’Economie Rurale, Laboratoire sol-eau-plantes, Bamako, Mali; (8) Université de N’Djamena, Département de géologie, N’Djamena, Chad; (9) Université de Tunis, Tunis, Tunisia; (10) Institut de Recherche pour le Développement, UMR EcoSols, Montpellier, France; (11) Centre Régional AGRHYMET, Niamey, Niger, Republic of; (12) Institut de Recherche pour le Développement (IRD), UMR EcoSols, Antananarivo, Madagascar; (13) FAO, ESA, Rome, Italy

Since the food riots in 2008 and 2009 at the international level, some strategies are in place to tackle the problem of food security. As soils are the main support of agricultural activities, it is necessary to preserve them because of their non-renewable status at the scale of a generation, agricultural activities and forest sensu lato.

On the other hand, African agriculture has to face both climates changes which can be a source of many threats and demographic pressure which goes increasing. In order to feed people, it is necessary to adopt agricultural practices which preserve soils and the ecosystem services they provide, such as food production and biomass, regulation and filtering of waters, the mitigation and adaptation to climate change, the conservation of biodiversity. Soil organic carbon is recognized as an indicator of fertility and productivity, two essential qualities for the autonomy and the food security of many African countries.

To meet these challenges, the implementation of agricultural practices that promote alternative agricultural production systems focused on optimal management of organic matter and thus the soil carbon are proposed and considered as an agriculture that sustainably increases productivity, reduces climate (adaptation and greenhouse gases mitigation, and enhances achievement of national food security and development goals» according to the FAO.

Many of these practices are already implemented in Sub-
Saharan Africa (SSA) such as agroforestry, zai practices, and conservation agriculture. However, their extent and their efficiency to increase productivity, to be resilient and to mitigate GES need to be documented.

The “Soil Carbon Network for sustainable agriculture in Africa” or CaSA network was created in SSA in order to regroup the African soil scientists working on sustainable agriculture in link with soil organic carbon sequestration at SSA level. This network aims to:

(1) replace the soil as the central support of production systems;
(2) show that the simple maintenance of soil carbon is essential, especially in arid and semi-arid areas;
(3) quantify the impact of the management practices on carbon sequestration in the soil for the different pedoclimatic African situations;
(4) promote research in connection with civil society and development agencies;
(5) facilitate access of the results of research to policy makers; improve the dissemination to civil society and farmers;
(6) strengthen the capacity of the teams and training expertise.

CasA network regroup more than 15 African and European research institutions distributed among 10 African countries (Benin, Burkina Faso, Cameroon, Ivory Coast, Mali, Senegal, Chad, Tunisia, Morocco and Madagascar) and 5 European countries. An end-produce of this network will be a book on combined research results of soil organic carbon storage/sequestration in sustainable agriculture at SSA level; it will be presented at the COP21 in Paris.

Local beliefs and strategies of adaptation to climate change in Korhogo (Côte d’Ivoire)

N. Boko (1)
(1) UNIVERSITE FELIX HOUPHOUE-JOINT, SOCIOLIGIE, ABIDJAN, Ivory Coast

The precedent decades, the area of Korhogo, Côte d’Ivoire, has experienced climate variability which disturbs populations’ agricultural activities. This survey has been conducted from March 2009 to February 2012 in order to identify the mechanisms of adaptation of the population to climate change, to study the social, economical or environmental to the populations, and their endogenous strategies of adaptation. A qualitative approach based on semi-structured interviews, life stories and focus groups has been carried out for this study. The historical and comprehensive method enabled to establish a relationship between populations’ perceptions and beliefs and, the indicators of climate variability and environment changes but also, their endogenous strategies of adaptation. As indicators, the populations notice an extension of the dry season at the expenses of the rain season, advanced deterioration of vegetation, drainage of sources of water supply (rivers, backwaters and wells) and disappearance of some animals like elephant and hyena and, some floristic species used by sculptors and traditional healers.

The survey also shows that the causes of the phenomenon are not only related to human activities but are mystical or metaphysical (non-compliance with customary practices, fastness, lack of rain, God in the bush, commit blood crimes) and prohibitions related to nature: the multiplicity of religions, degradation of traditional values and the upheaval of society’s rules (non-compliance of the elderly, lack of respect for the living dead, consulting « Fodonons » or rainmakers and also request the help of marabouts or charlatans for sacrifices in the direction of ancestors and gods’ protectors, prayers are organized in mosques and churches asking God for protection and return of the rains. Eventually, the survey shows that populations’ adaptation strategies are mainly based on local traditional beliefs and knowledge which are at the same time a barrier and an opportunity for the adaptation to climate variability. This article shows in the same time the importance of taking into account local knowledge in order to develop efficient adaptation strategies.

Dealing with integrated soil research and training to face climate change, overcome land degradation and ensure food security in Madagascar

E. Blanchart (1); H. Razakanarimamboz (2); T. Rafolisy (2); A. Andriamananjara (2); TM. Razafimbelo (3); L. Rabeharisoa (4); M. Bernoux (5); A. Albrecht (5); T. Chevallier (5); JL. Chotte (5); L. Bernard (1); T. Becquer (5); J. Trap (6); M. Brossard (5); C. Feller (5); M. Chapuis-Lardy (5); J. Larvy-Delarivière (5); D. Masse (5)

(1) Institut de Recherche pour le Développement (IRD), UMR Eco&Sols, Antananarivo, Madagascar; (2) Laboratoire des radioisotopes et des applications nucléaires (LRA) et de l’Institut national de recherches agronomiques (INRA), Antananarivo, Madagascar; (3) University of Antananarivo, Laboratoire des Radiotopes, Antananarivo, Madagascar; (4) University of Antananarivo, Laboratoire des Radio Isotopes, Antananarivo, Madagascar; (5) University de Recherche pour le Développement, UMR Eco&Sols, Montpellier, France; (6) Institut de Recherche pour le Développement (IRD), UMR eco&sols, Antananarivo, France

Madagascar in a tropical country, hotspot of biodiversity, where people welfare greatly depends on natural resources, i.e., soil, water, forests, biodiversity. As a rural country, the need of agricultural development is important inducing pressures on lands which have negative feedbacks on population such as soil erosion, loss of fertility, loss of biodiversity, vulnerability to climate change. Development of sustainable land uses is essential, especially in arid and semi-arid areas, to mitigate GES need to be documented.

and conservation agriculture. However, their extent and their efficiency to increase productivity, to be resilient and to mitigate GES need to be documented.

The “Soil Carbon Network for sustainable agriculture in Africa” or CaSA network was created in SSA in order to regroup the African soil scientists working on sustainable agriculture in link with soil organic carbon sequestration at SSA level. This network aims to:

(1) replace the soil as the central support of production systems;
(2) show that the simple maintenance of soil carbon is essential, especially in arid and semi-arid areas;
(3) quantify the impact of the management practices on carbon sequestration in the soil for the different pedoclimatic African situations;
(4) promote research in connection with civil society and development agencies;
(5) facilitate access of the results of research to policy makers; improve the dissemination to civil society and farmers;
(6) strengthen the capacity of the teams and training expertise.

CasA network regroup more than 15 African and European research institutions distributed among 10 African countries (Benin, Burkina Faso, Cameroon, Ivory Coast, Mali, Senegal, Chad, Tunisia, Morocco and Madagascar) and 5 European countries. An end-produce of this network will be a book on combined research results of soil organic carbon storage/sequestration in sustainable agriculture at SSA level; it will be presented at the COP21 in Paris.

Local beliefs and strategies of adaptation to climate change in Korhogo (Côte d’Ivoire)

N. Boko (1)
(1) UNIVERSITE FELIX HOUPHOUE-JOINT, SOCIOLIGIE, ABIDJAN, Ivory Coast

The precedent decades, the area of Korhogo, Côte d’Ivoire, has experienced climate variability which disturbs populations’ agricultural activities. This survey has been conducted from March 2009 to February 2012 in order to identify the mechanisms of adaptation of the population to climate change, to study the social, economical or environmental to the populations, and their endogenous strategies of adaptation. A qualitative approach based on semi-structured interviews, life stories and focus groups has been carried out for this study. The historical and comprehensive method enabled to establish a relationship between populations’ perceptions and beliefs and, the indicators of climate variability and environment changes but also, their endogenous strategies of adaptation. As indicators, the populations notice an extension of the dry season at the expenses of the rain season, advanced deterioration of vegetation, drainage of sources of water supply (rivers, backwaters and wells) and disappearance of some animals like elephant and hyena and, some floristic species used by sculptors and traditional healers.

The survey also shows that the causes of the phenomenon are not only related to human activities but are mystical or metaphysical (non-compliance with customary practices, fastness, lack of rain, God in the bush, commit blood crimes) and prohibitions related to nature: the multiplicity of religions, degradation of traditional values and the upheaval of society’s rules (non-compliance of the elderly, lack of respect for the living dead, consulting « Fodonons » or rainmakers and also request the help of marabouts or charlatans for sacrifices in the direction of ancestors and gods’ protectors, prayers are organized in mosques and churches asking God for protection and return of the rains. Eventually, the survey shows that populations’ adaptation strategies are mainly based on local traditional beliefs and knowledge which are at the same time a barrier and an opportunity for the adaptation to climate variability. This article shows in the same time the importance of taking into account local knowledge in order to develop efficient adaptation strategies.

Dealing with integrated soil research and training to face climate change, overcome land degradation and ensure food security in Madagascar

E. Blanchart (1); H. Razakanarimamboz (2); T. Rafolisy (2); A. Andriamananjara (2); TM. Razafimbelo (3); L. Rabeharisoa (4); M. Bernoux (5); A. Albrecht (5); T. Chevallier (5); JL. Chotte (5); L. Bernard (1); T. Becquer (5); J. Trap (6); M. Brossard (5); C. Feller (5); M. Chapuis-Lardy (5); J. Larvy-Delarivière (5); D. Masse (5)

(1) Institut de Recherche pour le Développement (IRD), UMR Eco&Sols, Antananarivo, Madagascar; (2) Laboratoire des radioisotopes et des applications nucléaires (LRA) et de l’Institut national de recherches agronomiques (INRA), Antananarivo, Madagascar; (3) University of Antananarivo, Laboratoire des Radio Isotopes, Antananarivo, Madagascar; (4) University of Antananarivo, Laboratoire des Radio Isotopes, Antananarivo, Madagascar; (5) University de Recherche pour le Développement, UMR Eco&Sols, Montpellier, France; (6) Institut de Recherche pour le Développement (IRD), UMR eco&sols, Antananarivo, France

Madagascar in a tropical country, hotspot of biodiversity, where people welfare greatly depends on natural resources, i.e., soil, water, forests, biodiversity. As a rural country, the need of agricultural development is important inducing pressures on lands which have negative feedbacks on population such as soil erosion, loss of fertility, loss of biodiversity, vulnerability to climate change. Development of sustainable land uses is essential, especially in arid and semi-arid areas, to mitigate GES need to be documented.
the ecosystem services measured. Carbon storage in vegetation and soil pools were measured or assessed using modern methodologies and technologies such as Medium InfraRed Spectroscopy MIRS, digital mapping/RS. Modelling (Ex-Ax, Ex Ante Carbon-balance-Tool, FAQ) was also used for upscaling and mapping for decision making on a sustainable development.

Some results showed that natural forests and agroecological systems were the agroecosystems which allow soil carbon sequestration and there could be as much as carbon in soil pool as in biomass pool, or even more (particularly in natural forests). Actually, they could store up to 100 Mg Ch. ha$^{-1}$ in depth of 1 m, and more than 70 Mg Ch. ha$^{-1}$ in 100 m depth[F2], particularly in forest ecosystems.

Soil biodiversity has especially been studied in cropped fields from a functional point of view. The aim of these studies is to understand which and how soil organisms are involved in different ecological functions, i.e., nutrient cycling, carbon dynamics and maintenance of soil structure. These studies are planned to be extended to forest systems.

The municipal solid waste (MSW) management studies showed that MSW composting reduced the amount of deposits in landfill (65% of initial mass of windrow) and created a product at relatively low-cost that is suitable for agricultural purposes. And after six years of organic fertilization the stock of SOM has increased by 48%, and the content of Olsen P and resin P, has increased respectively by 85% and 35%.

From a teaching point of view these issues are now integrated in different university courses such as the master or diploma in Agroecology ( chiefly Agroecology, Biodiversity, Climate–Change, University of Antananarivo), the Doctoral School A2E (Agriculture, breeding, environment). The research conducted on soil ecosystem services for poverty alleviation and population development permitted the training of more than 15 PhDs. Efforts are also made by the team to train environment and agriculture stakeholders.

**P-3325-03**

**The influence of stand-level attributes on wind damage probability of industrial tree plantation areas in Mindanao, Philippines**

A. Codilan (1); N. Shiraishi (2)

(1) Institute of Renewable Natural Resources, College of forestry and natural resources university of the philippines, los baños, Los Baños Laguna, Philippines; (2) Laboratory of Forest Management, Department of forest science university of tokyo, Tokyo, Japan

In the past decade, the increased frequency and intensity of typhoons brought by climate change that had clearly brought severe damages to industrial tree plantations (ITP) in the Philippines. These damages resulted in loss of high-value timber and increased economic costs. The risk of wind damage from strong storms and typhoons should be an important component of plantation management plans. The problem, however, is that risks that were not conceived before may have become relevant in the past and the future. ITP in Mindanao, Philippines where the unprecedented increase in the frequency of storms and typhoons is now causing serious wind damages to plantations. In this consideration, the site probability of wind damage was estimated empirically using logistic regression analysis. Specifically, the influence of stand-level attributes such as average stand height, elevation and topographic exposure on damage probability were assessed. For the analysis, post-storm inventory data from 2012 Typhoon Bopha, in combination with previous stand inventory data, were used.

Results show that all three stand-level variables are influential and that they have a direct relationship with wind damage variables. By considering constant terrain conditions, the effect of average stand height was determined. Results indicate that there are critical average stand height levels where the site at high risk of being damaged. Critical stand heights of 25 m, 20 m and 10–15 m were identified for low, medium and high-risk level sites. This information, when combined with site productivity, could be used as a basis for determining risk-sensitive rotation ages at which certain species can be grown while reducing wind damage to plantation. Moreover, topographic stand variables used were derived from DEM thereby addressing the high-cost issue associated with developing probability models. Amidst the issue of climate change and the projected increase in weather disturbances, these results can improve management plans and make them more relevant and responsive to changing times.

**P-3325-04**

**We don’t want that offer «development! The reinvention of the territories in the semi-arid region of Brazil and Argentina: the case of the peasant community radios**

G. Lopes (1)

(1) University of nairobi, Buenos Aires, Argentina

We speak from a epistemic place, from a locus of enunciation. In modernity, the actors and institutions of rational European thinking relate and proclaim themselves as if they were located in a higher stage of human knowledge (developed) and as such, they award themselves the right to invalidate, discard, (de)authorize, ticketing as lower all the other modes of knowledge. From a decolonizing epistemic turn, we seek visualize and put in dialog two experiences of reinvention of the territories, carried forward by rural communities in arid regions of Latin America (Sergipe, Brazil and Santiago del Estero, Argentina), through its community radios. To propose and disseminate via radio the proposal of coexistence with the semi-arid and drylands, the peasants are looking for living an alternative to development. In this way, rethinking/ re-exist in the public policies of rural development, who proclaim the ‘fight to the drought’, the peasantry reimagines its territories participating in agro-ecological design. The model is an economic model of rural development (agro-exporting mining extractive), collecting/spreading ancestral knowledge and technologies for collection and distribution of water from rainfall which are recipient and the impacts of climate change. Look at that process demands geopolitics of knowledge, therefore the translation inter-cultural is the methodological tool necessary to achieve thinking and together with the other.

**P-3325-05**

**Exploring the links of artisanal fishery to climate change for developing a resilient livelihood for coastal communities in Ghana**

O. Pabi (1)

(1) University of Ghana, Institute for Environment and Sanitation Studies, Accra, France

By nature, artisanal fishery operates on minimal investments and basic technology, and is therefore considered less adaptable and highly vulnerable. The paper argues that, through productive management, it depends largely on natural marine productivity, which is closely linked to climatic elements. Studies conducted in the West African sub-region have not adequately demonstrated clearly the links between artisanal fishery and climate, due to the use of annual rather than intra-annual data and analyses. This impedes information generation suitable for informing fishery operational decisions, adaptive policy development and climate-resilient livelihood options. This study analyzed records of rainfall, atmospheric temperature, sea surface temperature (SST) and fish catch of three species with different sensitivities to temperature, on different time scales using time series techniques. Upwelling was derived from SST intensities, with fish catch of three species with different sensitivities to temperature, on different time scales using time series techniques. Upwelling was derived from SST using the Bakun Model. It examines the interactions between the variables at different time scales to determine exposures and sensitivities. It also sought verifications from fishers perspectives, based on experiences and knowledge in respect of climate change dynamics and real impacts on fishery. The results depicted clear association in trends of sea surface and atmospheric temperatures; seasonality of rainfall and upwelling, fish catch and SST intensities, with round sardinella and anchovy showing clear sensitivities to rainfall, atmospheric temperature, sea surface temperature (SST) and fish catch of three species with different sensitivities to temperature, on different time scales using time series techniques. Upwelling was derived from SST using the Bakun Model. It examines the interactions between the variables at different time scales to determine exposures and sensitivities. It also sought verifications from fishers perspectives, based on experiences and knowledge in respect of climate change dynamics and real impacts on fishery. The results depicted clear association in trends of sea surface and atmospheric temperatures; seasonality of rainfall and upwelling, fish catch and SST intensities, with round sardinella and anchovy showing clear sensitivities to temperature changes. Whereas the upwelling season period is typically three (3) months, in some cases it contributes some 60% of the total annual catch. Based on the evidence of high exposure and sensitivity of artisanal fishery to climate change, and overdependence of fishers on the artisanal fishery, the study proposes options of adaptive strategies for a climate change-resilient coastal fisher community livelihood.
ABSTRACT BOOK

P-3325-06

How can knowledge about health consequences promote acceptance of climate action?

R. Sauerborn (1) ; A. Flahault (2) ; D. Ganten, (3)
(1) Heidelberg University, Institute of public health, Heidelberg, Germany; (2) Université Paris 8 Descartes, Paris, France; (3) Charité University Hospital, Centre de santé publique virchow villermé, Berlin, Germany

Health is currently not prominent in climate policy. It is regarded as one of many climate sensitive sectors. However, arguments deriving from health and physiology, if properly communicated to climate decision makers, could play a strong role as a driving force to motivate them (and citizens) to accept new policies and new behaviors for the transformation towards a low carbon society. This is based on three sets of arguments, which have recently been corroborated by new evidence (since IPCC ARS), which we present, and which highlight further the need to communicate the strong influence health arguments should have at the COP21 negotiations. These sets of arguments are as follows:

(i) There are huge health benefits from climate friendly policies and behaviors. Although the concept is not new, but new evidence points to the large scope of known health benefits accruing from physical activity from walking and biking, insulated housing, low meat diets. Two recently identified co-benefits generate considerable additional health gains:

1. Large health gains from reducing local pollutants, particularly in low and middle income countries. Fine particles and black carbon have recently been recognized as “climate active pollutants”. Black carbon are of particular interest for climate policy, as reducing its emissions leads to a fast reduction of stocks in the atmosphere.

2. Recent population projections till 2100 significantly exceed previous UN estimates. Gerland et al. publishing their modeling results in Science 2014[1] project a 2100 population size of between 9.3 to 12.6 billions. This urgently call for even greater efforts for voluntary family planning, hence reaping even larger the linked health benefits accruing to mothers and their fewer children.

(ii) There are clear limits to society’s capacity to adapt to the projected health impact of climate change. This holds to some extent in a 2°C world, but definitely in a 4°C warmer world. This holds even given maximal resource allocation to the task (e.g. 2).

(iii) Heat stress lead to reduced in work productivity in a warmer world, particularly in a 4°C climate (e.g. 3). This concerns mainly the large populations in (sub-) tropical and arid areas and applies both to outdoor work, such as farming and construction and to indoor industrial production in non-air conditioned factories. Hence the physiological impossibility to work and generate further body heat is a health argument of significant bearing on economic output.

The above evidence-based health arguments provide a unique combination of positive news – reaping health gains from climate policy – and the reference to the ultimate driving force behind any climate policy and citizens behavior change: preserving our children’s health form the adverse health impacts of climate change.


K-3326-01

Increased frequency of major heatwaves and droughts in the Mediterranean

R. Trigo (1)
(1) Instituto Dom Luiz – Universidade de Lisboa, Lisbon, Portugal

The last IPCC Assessment Reports (IPCC, 2007, 2013) identify the Mediterranean region as a climate change and biodiversity “hot spot” with an increasing likelihood of suffering in the future drought episodes and severe heat waves. In fact, most studies using global and regional climate model results suggest that the Mediterranean will gain in general the most extreme heatwaves and their frequency in the 21st century. Thus, the overall tendency towards a drier Mediterranean climate is not independent of the simultaneous increase of the heatwaves frequency and magnitude in southern and central Europe. In fact, despite some contradictory results with state-of-the art models, these combined tendencies towards a drier and more extreme Mediterranean climate fits particularly well into the expected changes predicted by most models for this climate change “hot spot” region (IPCC, 2007, 2013).

Summer heat waves are controlled by intense anticyclonic circulation, often associated with upper tropospheric blocking high. Heat waves have been shown to be responsible for excessive mortality, such as the 2003 heat wave in Eastern Europe, which was associated with an excessive >50,000 fatalities (García-Herrera et al., 2010). Equally, heatwave events can be the main drivers of large wildfires occurrence, such as those that occurred in Portugal in 2003 with more than 430,000 ha burnt area (Trigo et al., 2006). Interestingly, this major heatwave was preceded by very dry conditions (winter and spring) in most of Western Europe, a factor that has been shown to play a crucial role in amplifying the heatwave magnitude (García-Herrera et al., 2010).

The summer of 2010 was exceptionally warm in Eastern Europe and large parts of Russia. In fact the anomalous 2010 warmth that caused adverse impacts exceeded the amplitude and spatial extent of the previous hottest summer of 2003 (Barriopedro et al., 2010). ‘Mega-heatwaves’ such as the 2003 and 2010 events displayed exceptional seasonal temperatures in a 500-yr long context over approximately 50% of Europe. According to regional and multi-model experiments the probability of summer experiencing ‘mega-heatwaves’ will increase by a factor of 5 to 10 within the next 40 years. The results also indicate that the temperature maxima observed during these heatwave episodes were associated with the simultaneous occurrence of outstanding anticyclonic blocking patterns and were preceded by relatively dry soils resulting from the lack of precipitation in winter and spring and an earlier retreat of snow cover.

The western Mediterranean is recurrently affected by drought episodes and therefore by the adverse effects associated that range from severe water shortages to economic losses and related social impacts. During the hydrological years of 2004/2005 and 2011/2012, Iberia was hit by two of the worst drought episodes ever recording in this semi-arid region (Trigo et al., 2013). These two drought episodes were extreme in both its magnitude and spatial extent and appear to fit the tendency toward an increase in the frequency of drought events in the Mediterranean basin (Sousa et al., 2011) partially driven by anthropogenic greenhouse gases emissions (Hoerling et al., 2012; Trigo et al., 2013).
The Medieval Climate Anomaly and Byzantium. A review of the evidence on economic performance, societal change and climatic fluctuations

E. Xoplaki (1) ; D. Fleitmann (2) ; A. Izdebski (3) ; J. Luterbacher (1) ; E. Zorita (4) ; S. Wagner (4) ; I. Telelis (5)

(1) Justus–Liebig–University Giessen, Geophysics, Climatology, Climate Dynamics and Climate Change, Giessen, Germany; (2) University of Reading, Department of archaeology: school of human and environmental sciences, Reading, United Kingdom; (3) Jagiellonian University, Institute of history: byzantine history department, Krakow, Poland; (4) Helmholtz-Zentrum Geesthacht, Institute of coastal research, Geesthacht, Germany; (5) Academy of Athens, Research center for greek and latin literature, Athens, Greece

The study of the unusual climate patterns and their impact on ecosystems and societies during medieval times is of considerable interest for scholars of various disciplines such as past, current and future climate researchers, climatic impacts scientists, historians, archaeologists, anthropologists, among others. The global, hemispheric and continental climate variability, the associated forcing factors and potential dynamic origin of the Medieval Climate Anomaly (in this work ca. 850 - 1300 AD) have been the focus of many studies. Although the wealth of paleoclimate information for the last two millennia available in the Mediterranean basin and to a lesser extent in the Eastern Mediterranean, the character of paleoclimate records in combination with the inhomogeneous proxy records and distribution during medieval times still restricts scientists from critically assessing the manifestation of the MCA on a regional scale and further to a high temporally and spatially resolved characterization of the climate patterns and associated societal and environmental impacts for specific areas as the Eastern Mediterranean.

During the Medieval Climate Anomaly, Byzantium, a medieval empire encompassing the northern part of the Eastern Mediterranean, had formed an expanding society with a thriving economy and complex political as well as cultural institutions. Byzantium as a medieval society left a considerable body of written evidence, enabling the use of detailed information to investigate potential connections between the societal impact of climate change in the period that spans from the moment when the Byzantine state and economy began to recover after the crisis of the so-called Dark Age, and until the period that followed the fall of Constantinople in AD 1204.

This study aims at assessing the manifestation of the MCA in the Eastern Mediterranean, and linking the existing knowledge about the character and extent of the Medieval Climate Anomaly during medieval times in the Eastern Mediterranean, both historical (textual), palaeoenvironmental, and model-based, with what is known about the socio-economic processes taking place in the Byzantine Empire at that time.

Rising concerns about ocean acidification and warming in the Mediterranean Sea

P. Ziveri (1)

(1) Institute of Environmental Science and Technology (ICTA), Universitat Autònoma de Barcelona, Bellaterra (Barcelona), Spain

The Mediterranean Sea is facing large biogeochemical changes driven by both climatic and non-climatic drivers. Unprecedented high rates of CO2 into the atmosphere are responsible for two important drivers such as ocean acidification and warming that are rapidly altering the physico-chemical seawater properties with consequences for the marine ecosystems and ecosystem services.

There are rising concerns since this is one of the regions warming fastest under climate change and acidifying with a similar rate as subtropical regions. This marginal sea is also facing increasing anthropogenic pressures due to human activities. The IPCC in its various reports has established a clear link among global warming, climate change, SLR and coastal livelihood security. There is growing concern in France of climate change and sea-level rise. There is enough information to identify coastal areas that may be affected. Lambeck and Bard (2000) examined the evidence for relative sea-level change along the French Mediterranean coast. Considerable changes have been observed in the last two decades for the sea-level change along the French Mediterranean coast. Pourmandre et al. (2008) have found that in spite of the stance taken by political figures, general attitudes in France regarding climatic hazards appear to lag behind scientific warnings. The established fact that anthropogenic factors account for one of the major contributors to climate change makes it necessary to prevent it to spiral further. With the worst possible efforts around the globe to combat climate change, it is felt that people are still not as seriously aware/alarmed of the expected future risk as they should be. In view of this the present study has attempted to understand aspects of human–climate interaction through a comparative study between coastal cities of India and France. The study is intended at exploring how the coastal population of Indian and French metropolitan cities perceive climate change, how much aware and concerned they are, what guides their opinions, judgments, behaviours, and actions, how efficient they find themselves in adapting with the situation, what adaptation strategies they implement and how competent do they find themselves in terms of coping strategies in relation to the current phenomenon of changing climate. The study enables comparison of data collected from coastal residents of 400 respondents in coastal metropolitan areas of Marseille (1,7 million inhabitants), Nice (a little less than 1 million inhabitants) with the researcher’s existing data for Indian metropolitan coastal cities of Mumbai and Chennai (400 respondents), both highly vulnerable to climate change related accelerated sea level rise. A specially designed questionnaire called Climate Change Perception Inventory (CCPI) by Rishi et al. (2009) would be used to collect data from French population. The tool is based on Likert type format comprising of 48 items (in its original version) pertaining to perceptual and attitudinal components of climate change. A correlational research study design was used to study the relation between different study variables which would be subject to regression analysis for making predictions in regard to climate change.

This study will provide an understanding of mindset of people in urban settlements on climate change. Not only that, it will also help in understanding the level of climate change distress of people with regard to climate change and also what are their actions and reactions in the changing climate scenario. Through Assessment of perceptions and attributes of people in regards to Behavioral and Affective dimensions of Human–Climate Interface, one would better be able to determine the level of sharing responsibility regarding changing climate. By studying the pattern of behavioral adaptation to climate change, it would be possible to identify and compare what coping strategies people in coastal cities of India and France are using/are required to deal with the phenomenon of climate change.

The present study is directly in line with Article 6 of New Delhi Work Programme of UNFCCC (2007) in which special effort to foster psychological/behavioral change has been
Stressed through public awareness. Hence, it fulfills a very strong requirement to conduct behavioral study in the area of climate change.

O-3326-02

Current and future Mediterranean Sea ecosystem functioning in relation with global change: The MERMEX/MISTRALS project

R. Sempéré (1); X. Durrieu De Madron (2); C. Guieu (3); I. Paireaud (4)

(1) CNRS, Mediterranean Institute of Oceanography (MIO), Marseille, France; (2) CEFREM, CNRS-université de perpignan, Perpignan, France; (3) CNRS-UPMC, Villefranche sur mer, France; (4) IFREMER, Lerparc, La Seyne/mer, France

The semi-enclosed nature of the Mediterranean Sea, together with its smaller inertia due to the relative short residence time of its water masses, make it highly reactive to external forcing, in particular variations of water, energy and matter fluxes at the interfaces. This region, which has been identified as a “hotspot” for climate change, is therefore expected to experience environmental impacts that are considerably greater than those in many other places around the world. These natural processes interact with the increasing demographic and economic developments occurring heterogeneously in the coastal zone, making the Mediterranean even more sensitive. The context for climate change includes single forcing (hydrodynamics, solar radiation, temperature and acidification, chemical contaminants) and combined forcings (e.g. stoichiometry, extreme events) affecting the biogeochemical fluxes and ecosystem functioning are explored within the project MERMEX in the framework of MISTRALS program. MERMEX project based on the MERMEX(*) is dedicated to the response of Mediterranean ecosystems and biodiversity to climate changes and anthropogenic pressure. MERMEX aims to deepen the current understanding of the Mediterranean marine ecosystems to better anticipate their upcoming evolution. It is focusing on the response of ecosystems to modifications of physico-chemical forcing at various scales, both in time and space, linked to changing environmental conditions and increasing human pressure. Four years MERMEX results clearly showed that several processes including winter dense surface water convection, surface water stratification, river water discharge and episodic desert dust inputs play a major role on marine productivity as well as on organism community structure. Slight modifications of such processes that will be very likely affected by global change in 21st century can induce significant changes in Mediterranean Sea ecosystems.


O-3326-03

Climate Change Impact on Mediterranean Forest Functioning

V. Baldy (1); C. Fernandez (1); IM. Reiter (2); E. Ormeno (3); JP. Orts (3); M. Santonja (1); AC. Génard (1); A. Bousquet-V. Baldy (1); C. Fernandez (1); IM. Reiter (2); E. Ormeno (3)

(1) Aix-Marseille University, CREQAM, Aix en Provence, France; (2) Institut Méditerranéen de Biodiversité et d’Ecologie Marine et Continentale, Aix-en-Provence, France; (3) Aix Marseille University, Ot-med, Aix en Provence, France; (4) CNRS, CEREGE, Aix-en-Provence, France; (5) Université Paris Est Creteil, Liphar, Paris, France

The Mediterranean Basin is a well-documented history of climatic fluctuations throughout the span of its human occupation. Detailing past climatic changes and predicting those in the future is thought of as the task for sophisticated climate modeling, while investigating the human consequences of climatic changes is a major challenge for the social sciences. The AMENOphYS project combines the two and explores the limits of cultural adaptability to climatic shifts in the Mediterranean through a modeling approach, combining paleoclimatic data, GIS-based landscape evolution modeling, agroecosystem modeling, and agent-based modeling to ask how past climate change in the Mediterranean Basin directly affected the lives of the region’s inhabitants, and which factors were most salient in rendering climate changes more or less survivable.

Lessons from the Past: Modeling past human adaptation to climatic change in the Mediterranean Basin

A. Kirman (1); A. Bonneau (2); D. Contreras, (3); J. Guiot (4); N. Hanaki (1); C. Thomas (1)

(1) Aix Marseille University, CREQAM, Aix en Provence, France; (2) Institut Méditerranéen de Biodiversité et d’Ecologie Marine et Continentale, Aix-en-Provence, France; (3) Aix Marseille University, Ot-med, Aix en Provence, France; (4) CNRS, CEREGE, Aix-en-Provence, France; (5) Université Paris Est Creteil, Liphar, Paris, France

The Mediterranean Basin is a well-documented history of climatic fluctuations throughout the span of its human occupation. Detailing past climatic changes and predicting those in the future is thought of as the task for sophisticated climate modeling, while investigating the human consequences of climatic changes is a major challenge for the social sciences. The AMENOphYS project combines the two and explores the limits of cultural adaptability to climatic shifts in the Mediterranean through a modeling approach, combining paleoclimatic data, GIS-based landscape evolution modeling, agroecosystem modeling, and agent-based modeling to ask how past climate change in the Mediterranean directly affected the lives of the region’s inhabitants, and which factors were most salient in rendering climate changes more or less survivable.

There is an abundance of literature - archaeological, historical, paleoclimatic, and paleoenvironmental - born out of the reasonable premise that past climatic shifts were of such magnitude that they had cultural consequences. Such work, however, has struggled to move beyond correlation; we aim to articulate these links between paleoenvironmental and cultural change and to thereby tackle what has been a persistent challenge. This will improve our understanding of cultural trajectories, of human ecological footprints, and provide a strategy for untangling human and environmental histories in the long term. It will make the human experience directly relevant to current global realities and challenges.

Our models aim to provide explicit, well-formulated mechanisms linking biological responses to climate changes, thereby enabling the articulation of testable hypotheses that can be compared to empirical evidence. Questions of scale and resolution are fundamental. Environmental parameters are generally the purview of environmental modeling and paleoclimate studies - where spatial scales are regional and temporal scales are centennial, if not millennial. In
contrast, social scientific explanation relies fundamentally on human decision-making at local and annual or decadal scales.

Agent-based modeling can contribute significantly to reducing this important interpretative gap. We model the human consequences of climatic change, with a view to exploring their variability across different geographies, production regimes (i.e., subsistence practice and technologically enabled resources), demographic, sociopolitical and economic contexts, and environmental inheritances. This will provide a means of articulating linking mechanisms where they cannot be directly observed.

Using landscape evolution and agroecosystem models in a feedback system with agent-based models of small Mediterranean coastal towns and starting from an example of Provencal geography, this project explores the effects of climatic shifts, legacies of human activity, available subsistence options and technologies, and community size and organization on vulnerability and resilience.

3326-POSTER PRESENTATIONS

P-3326-01

Modelling blooms of comb jellyfish M. M. leidyi -population under Mediterranean climate change

E. Alekseenko (1) ; M. Baklouti (1) ; F. Carlotti (1)
(1) Mediterranean Institute of Oceanography, Marseille, France

The massive outburst of gelatinous plankton has important socio-economic impacts, particularly affecting tourism, fishing, fish farming, and also impact on the structure of the pelagic ecosystem. Some species are opportunistic invaders that can cause permanent damage to the native fauna. This is particularly the case of comb jellyfish Mnemiopsis leidyi, a kind of gelatinous plankton that can form dense patches and, as a predator of fish larvae and other zooplankton, can have disastrous consequences on fish stocks and other aquatic resources. The potential for outbreaks of this species is based on its growth capacity and high tolerance to environmental conditions particularly considering salinity and temperature, allowing M. leidyi establishment in highly contrasting ecosystems (ICESM, 2014). High numbers of M. leidyi along the Mediterranean coastlines of Israel, Italy, and Spain and other Mediterranean countries (CIESM, 2014) were recorded during the last years. This fact strongly suggests that M. leidyi population is established in the Mediterranean coasts. However the specific causes and mechanisms of M. leidyi development are not well identified, and the lack of data makes any further investigation difficult (Boero, 2013).

Modelling can provide an additional understanding of mechanisms through the definition of the environmental characteristics that could support and/or favor M. leidyi and the description of the associated changes in the planktonic community structure. The aim of the present study is to understand the potential direct (temperature, salinity and nutrient inputs) and indirect (climate changes) impacts of climate changes on M. leidyi blooms in the Gulf of Lions (NW Mediterranean Sea) using the biogeochemical model Eco3M-MED (Baklouti et al., 2006a,b, Alekseenko et al., 2014) coupled with the hydrodynamical model MARSD (Lazure&Dumas, 2008). A M. leidyi compartment has been introduced in the Eco3M-MED model, in such a way that some of the physiological and demographic traits of this species are represented. A study on M. leidyi physiology and eating behavior has first been conducted with the biogeochemical model. Then, different scenarios have been simulated in order to analyze the role of several environmental parameters, namely, temperature, salinity and nutrient inputs of the Rhone River, on the seasonal variability of M. leidyi and the structure of the trophic web. The study is focused on the period 2001-2011 and the output of the model for this period has already been partially validated (Alekseenko et al., 2014).

Acknowledgements

The present research is a contribution to the Labex OT-Med (n° ANR-11-LABX-0061) funded by the French Government «Investissements d’Avenir» program of the French National Research Agency (ANR) through the A*MIDEX project (n° ANR-11-IDEX-0001-02).

References


P-3326-02

Surface runoff evaluation watershed Tunisian-Algerian border modeling with software WEAP

M. Ben Abdelmalek (1) ; I. Nouri, (1)
(1) l’Institut National Agronomique de Tunisie, génie rural eaux et forets, city El mahrajene,El manzah 1, Tunis , Tunisia

Tunisia is considered among the countries least endowed with water resources in the Mediterranean basin. The most significant changes in rainfall and making the periods of drought longer are the factors aggravating the imbalance between supply and demand water.

The main objective of this work is the hydrological study of the major trans-boundary watersheds Tunisian–Algerian border regions.

The methodology used was based on the creation of a daily database (1 September 2009 – 31 August 2013) of rainfall in 43 stations, statistical analysis and spatial measurements. It also used for modeling the physical system of trans-boundary basins the software WEAP. The assessment of daily surface resources, demands and runoff were used to develop a daily dynamic management model.

The modeling results showed that Algeria’s surface flows to Tunisia are mainly presented through the Oued Medjerda, Mellegue and El Kbir. The average annual intake is around 8204 million m3 which 22.41% are insured by the river of Medjerda , 63.51% from Mellegue and 14.08% from El Kbir one. The largest flows are carried by the Mellegue river which is valued at 2505 m3/s. The Medjerda and El Kbir river have recorded peak flows 806 and 732 m3/s, respectively, during the period of the study.

The simulation of climate scenarios and investment, showed that the change in the water flow follows the variation of rainfall. It is shown by simulation that if rainfall increases by 300% (very humid scenario), runoff can increase up to 265%. On the contrary, if rainfall decreases from 80% (very dry scenario), surface runoff would be reduced by about 85%. The first version of trans-boundary river basin management model developed Tunisian-Algerian proved useful for modeling of surface water resources for large hydrological catchments.
Statistical and experimental approaches for demonstrating the effect of climate changes on the flowering dates as a road map for tree adaptations in the Mediterranean region

A. El Yaacoubi (1); A. Oukabli (2); M. Hafidi (1); J.M. Legave (3)

(1) Moulay Ismail university, Meknes, Morocco; (2) INRA, Meknes, Morocco; (3) INRA, Montpellier, France

In this study two approaches were used to highlight the effect of climate changes on the tree behavior. The statistical approach was carried out in three geographically contrasting countries of the Mediterranean region. It aims to understand the impact of climate change, particularly the temperature increases, on phenological stage of three taxonomically different species (early and late–spring–flowering species). Three species, namely olive, apple and almond were investigated to highlight the phenological behavior of one species at different locations (mild and cold regions) and different species at one location. Climate and phenological data were collected from Morocco, France and Italy over the last 40 years. The experimental approach was done in mild (Morocco) and temperate (France) areas in the Mediterranean in order to interpret the effect of the climate changes on the dormancy and flowering of almond, apple, and almond were investigated. In each location, two experimental approaches were used during two successive seasons: one–single cutting test to assess the dormancy in vegetative and floral buds for floral buds. The target of combining these approaches is to interpret the wholly tree dormancy behavior in vegetative and floral buds of one species in different regions and different species in the same site. The analysis of data showed a strong warming in the northern locations (coldest areas), particularly in Nîmes, compared to the southern ones (warmer locations) during the period October to May. The marked warming in mild locations since the end of 1980s in France (the beginning of 1990s in Italy and Morocco) resulted in blooming earliness, with regional patterns in terms of impact. The late–spring–flowering species (olive and apple) show a remarkable sensitivity to continuous warming in different areas. No flowering earliness was observed in early–spring–flowering species (almond), due to the stability of mean temperature during February. Thus, a strong control of mean temperature during the forcing period on flowering earliness of apple was found in all areas. Physiological processes (dormancy and dormancy release) of trees during the dormant and growth period explain, in part, the regional differences of flowering dates among species and regions. In terms of tree dormancy dynamics, deeper apple dormancy was evinced in the temperate area compared to the mild one, showing a strong correlation with winter temperature. In Morocco, the almond and low–chill apple cultivars seemed to behave similarly, showing low Mean Time of Budburst and permanently high Rate of Budburst. The rates of dormancy release show a high variation in vegetative buds and Tabuenca test for floral buds. The target species at different locations (mild and cold regions) and different species in the same site. Analysis of data on temperature showed a strong trend of solutes importation and utilization by floral buds were different in almond and apple. Mechanisms of transition from the endodormant to the ecodormant phase of apple flower buds in Morocco. However in apple, the significant increase of masses was earlier in fresh bud mass, while it was later in dry bud masses in both sites. The transition from the endodormant to the ecodormant phase of apple flower buds was distinct in both locations. Mechanisms of solutes importation and utilization by floral buds were different in both locations. Overall, the pronounced warming in the southern France reflects a relative trend toward aridity of climate at this site, and consequently some vulnerability of fruit trees. As result, the process of dormancy and flowering in Mediterranean areas in the future can be represented by that in a low latitude locations at present (southern areas), particularly for apple. The agronomic consequences caused by global warming are already expressed in the southern areas (floral abortion, heterogeneity and delayed flowering time...). The apple cropping is limited only in the upland location (high altitude). In France, ominously, production irregularities related to climate change during the last few years were exceptional. This requires immediate intervention to find some ways of adaptation or improvement as part of a regional strategy to fight against this scourge in context of food security. Conclusions: Almond and apple require long periods of dormancy and plant breeding while the change of vulnerable crop by others (such as almond well adapted in mild climate areas) is a way of adaptation.
the late 19th century that manage issues related to the crisis, like that posed by the threat of climate change. This presentation will analyse how maintaining canal-based hydraulic infrastructure is of central importance for perpetuating sustainable farming at the regional scale. For this to occur, ASAs must now acquire the canals they manage also have other uses; their management needs to take into account the multi-functionality of the canals and embrace new challenges which are both environmental and social (replenishing the water table, flood management, promoting the heritage value of the canals, etc.). We will take an historical approach to show how agricultural actors created types of organisations that were both unique and solidarity-based which allowed them to manage droughts and flooding (particularly in the Durance basin). Other forms of multi–actor governance are emerging today: e.g., canal contracts, the signing of bi– or multi–lateral partnership agreements and “Agora” assemblies for the operational governance of water. Such projects are proof of the dynamic thrust of the agricultural profession, but they also raise questions about the funding of such initiatives and therefore their long–term viability.

P-3326-07
Climate change impacts on water and local adaptation strategies in the Mediterranean: security versus sustainability
I. La Jeunesse (1); R. Ludwig (2); P. Quevauiullier (3); C. Cirelli (4)

(1) University François Rabelais Tours, CNRS 7324 Citeres, Geography, Tours, France; (2) Ludwig-Maximilians–University Munich (LMU), institute of geography, Munich, Germany; (3) Vrije Universiteit Brussel (VUB), Hydrology and Hydrological engineering, Brussels, Belgium; (4) University François Rabelais of Tours, CNRS 7324 Citeres, Cost, Tours, France

Introduction
Climate change is predicted to lead to raising temperatures in the Mediterranean region and reduced rainfall, with possible worsening of water resource shortages that Mediterranean basin is already experiencing. Climate change is thus probably likely to lead to different situations among users. A conservative approach is to believe that changes correspond to situations that have already occurred in the past and that, with a successful management of these conflicts through the use of a single integrated water management with local actors, there would be no new challenge in facing these situations. However, in the present state of knowledge on the impact of climate changes, it is then recognized that the chains of causes and effects will lead to different situations. Thus, tools and procedures previously developed, might become obsolete if they are not updated continuously with advances in knowledge about criteria explaining the chain of causes and effects between climate changes, water availability and water uses.

In this context, models undeniably represent an educational support for the dissemination of scientific results in the science–policy interface to develop. But the support to the development of these models is also to the moderation of dissemination by experts as close as possible to local stakeholders and last but not least, for Europe, on the common implementation strategy of the water framework directive in coherence with the European and national adaptation strategies and plans.

Methods and Materials
The EU FP7 research project CLIMB, embedded in a cluster of three EU projects (the CLIWASEC cluster) about climate change–water–security, aimed to decrease uncertainties of hydrological modelling in the context of climate changes in the Mediterranean basin. For this purpose, CLIMB defined an ensemble of 4 GMC–RCM–combinations to generate climate data to be used by a set of hydrological models implemented at catchment scale for 2 case studies. Two periods have been embedded: 1971–1990 as the reference period, and 2041–2070 as the future period. To support the local dissemination of
scientific results of CLIMB, interactions with stakeholders have been included in the context of a study of water uses and water rivalries.

Results and Discussion
Impacts of climate change on temperatures, precipitations and flows have been described. They essentially affect the availability of water. According to interviewed stakeholders, it is notable that, for the Mediterranean region represented by CLIMB case studies, the main pressure on water resource during the last 20 years has been linked to the population growth and urbanization. The results have also underlined that the terms «climate change» have not been cited by stakeholders during both interviews and open questions in the questionnaires related to threat on water resource.

In other words, and considering that climate change is not considered as an issue for the stakeholders, the evolution of climate change over the last 20 years as not looked by them. This confirms the need to continue efforts on disseminating facts and figures about climate change to local water managers.

Conclusion
In the Mediterranean region represented by 7 case studies within the CLIMB project, the main answer to the increase of water demand, without considering climate change as a driving force, has been a progressive transfer of water. It seems that there is no spatial limit to this transfer with respect to national borders.

It has also been spotlighted that all analyzed water management plans mention desalination as an option, both for European case studies and non-European ones.

It seems that this represents the next step of water supplying in the Mediterranean region. While these adaptation provide water security, it is not coherent with climate change mitigation or adaptation strategies.

P-3326-08
Adaptive action pathways in rural and urban systems facing the challenges of Mediterranean changing climates: Comparative views of efforts and propositions for Europe and South America
E. Martinez (1) ; L. Bascuñán (2) ; K. Ruiz-Carrasco (3) ; A. Berrios (4)

Four millions is the car fleet recently recorded in Chile, a South American country inhabited by only 17 million people. This ratio of 23 cars for every 100 persons is causing great circulation problems in Santiago, where one third of the population live but also in smaller towns. Big cities or European agglomerations suffer from similar problems. Comconmitantly, our evaluations of social representation among car drivers about individual contribution to Green House Gases (GHG) indicate deep lack of basic knowledge on quantities emitted and on the contribution to Green House Gases (GHG). This is probably due to our low human sensitive and visual appreciation of GHG and our lesser common knowledge of the effective modes of possible compensations.

In our study we show that in countries with high economic growth, like Chile during the last four decades, social representation of sustainable development education systems is more associated to economic development than to social or environmental effects. Besides, critical visions on the development models are still much less present, although climate change towards desertification in countries like Chile is equal than that of south Sahel regions.

Finally we argue that connecting GHG compensation strategies to zero carbon agricultural practices could give impressing benefits to new urban and rural development strategies. More conscientiousness of climatic changes will result from strong government decisions, but our authorities must be well informed. The rural–urban connections could be based on existing taxation laws (like car circulation permits in Chile) and incentives to connections could be based on existing taxation laws that will result from strong government decisions, but our strategies to zero carbon agricultural practices could give rise for making the changes a real possibility.

Our hope with our vision is to contribute to:
1. More knowledge to take decisions on actions to reduce and to compensate GHG emissions, particularly those concerning agricultural practices and transport (that added are 25% of world emitted GHG).
2. To make this knowledge understandable to the most wide public
3. To link our propositions to sustainable health–care and food chains
4. To give examples of ongoing practices in the mentioned fields, from two distant Mediterranean regions (France and Chile) that are socially sustainable
5. To give education/formation to all publics a central role in the questionnaires related to threat on water resource.
6. To make this knowledge understandable to the most wide public
7. To make all public, from individuals to highest authorities, more sensible to accept the needed changes

We are the first generation (and the last one) that can make the changes. We cannot lose this opportunity. It is everybody’s task and everybody’s responsibility. We have all communication facilities for making COP21 a source of world’s hope not only for future climate based visions but also for building new human societies, where inter–connections can be much more acknowledged.

P-3326-09
Predicted climate change effects in a Mediterranean reservoir under different climate scenarios and management options
J. Prats Rodríguez (1) ; P.A. Danis (1)

In the Mediterranean area, water is a scarce resource, especially in the summer season. Good management of this resource is thus not only regarding quantitative aspects, but also regarding ecological and water quality. Climate change in the region is expected to result in an increase in air temperature that will affect water temperatures.

Water temperature is an important variable in freshwater ecosystems. It can affect the biology of freshwater organisms: it can modify the availability of water to the animals and plants, the possibility of living of some species, their physiology, distribution areas, behaviour, etc. In addition, the vertical distribution of heat in a lake or reservoir determines its hydrodynamic behaviour and by extension water quality. The thermal and hydrodynamic of a reservoir depends on external driving factors (hydrology, meteorology) and internal characteristics of the water body (depth of the inlets and outlets, morphometry, reservoir management). Process-based hydrodynamic models allow investigating the effect of the alteration of these characteristics and are interesting tools to address the effects of climate change in Mediterranean reservoirs and testing possible adaptations. In this work, we used the model EOLE to simulate the hydrodynamic and thermal behaviour of the reservoir of Bimont (Provence region, France). To account for the hydrodynamic model uncertainty, we used two different calibrations: one based agreements (like AMAPs in France). However further growth of such initiatives would need still stronger governance positions to limit growth of big cities, and to tax all carbon emitting production/consumption chains towards the promotion of changes of our ongoing agricultural and transportation paradigms. Conversely, the constraints to these changes could be counterbalanced by lower costs associated to improvement of poor public health–related parameters, another facet of modern globalization states. This is supported by the high nutritional value of some crops, like Andean quinoa, that respond well to agro ecological practices and can be cultivated worldwide under extreme climates. Our propositions could be implemented in all Mediterranean regions of the world, for which European and South American ones are good examples. These regions share strong urbanization, loss of biodiversity and migratory patterns among non-European countries so that education to have critical positions on these challenges should also be promoted.

1. More knowledge to take decisions on actions to reduce and to compensate GHG emissions, particularly those concerning agricultural practices and transport (that added are 25% of world emitted GHG).
2. To make this knowledge understandable to the most wide public
3. To link our propositions to sustainable health–care and food chains
4. To give examples of ongoing practices in the mentioned fields, from two distant Mediterranean regions (France and Chile) that are socially sustainable
5. To give education/formation to all publics a central role in the questionnaires related to threat on water resource.
6. To make this knowledge understandable to the most wide public
7. To make all public, from individuals to highest authorities, more sensible to accept the needed changes

We are the first generation (and the last one) that can make the changes. We cannot lose this opportunity. It is everybody’s task and everybody’s responsibility. We have all communication facilities for making COP21 a source of world’s hope not only for future climate based visions but also for building new human societies, where inter–connections can be much more acknowledged.

P-3326-09
Predicted climate change effects in a Mediterranean reservoir under different climate scenarios and management options
J. Prats Rodríguez (1) ; P.A. Danis (1)

In the Mediterranean area, water is a scarce resource, especially in the summer season. Good management of this resource is thus not only regarding quantitative aspects, but also regarding ecological and water quality. Climate change in the region is expected to result in an increase in air temperature that will affect water temperatures.

Water temperature is an important variable in freshwater ecosystems. It can affect the biology of freshwater organisms: it can modify the availability of water to the animals and plants, the possibility of living of some species, their physiology, distribution areas, behaviour, etc. In addition, the vertical distribution of heat in a lake or reservoir determines its hydrodynamic behaviour and by extension water quality. The thermal and hydrodynamic of a reservoir depends on external driving factors (hydrology, meteorology) and internal characteristics of the water body (depth of the inlets and outlets, morphometry, reservoir management). Process-based hydrodynamic models allow investigating the effect of the alteration of these characteristics and are interesting tools to address the effects of climate change in Mediterranean reservoirs and testing possible adaptations. In this work, we used the model EOLE to simulate the hydrodynamic and thermal behaviour of the reservoir of Bimont (Provence region, France). To account for the hydrodynamic model uncertainty, we used two different calibrations: one based agreements (like AMAPs in France). However further growth of such initiatives would need still stronger governance positions to limit growth of big cities, and to tax all carbon emitting production/consumption chains towards the promotion of changes of our ongoing agricultural and transportation paradigms. Conversely, the constraints to these changes could be counterbalanced by lower costs associated to improvement of poor public health–related parameters, another facet of modern globalization states. This is supported by the high nutritional value of some crops, like Andean quinoa, that respond well to agro ecological practices and can be cultivated worldwide under extreme climates. Our propositions could be implemented in all Mediterranean regions of the world, for which European and South American ones are good examples. These regions share strong urbanization, loss of biodiversity and migratory patterns among non-European countries so that education to have critical positions on these challenges should also be promoted.

1. More knowledge to take decisions on actions to reduce and to compensate GHG emissions, particularly those concerning agricultural practices and transport (that added are 25% of world emitted GHG).
2. To make this knowledge understandable to the most wide public
3. To link our propositions to sustainable health–care and food chains
4. To give examples of ongoing practices in the mentioned fields, from two distant Mediterranean regions (France and Chile) that are socially sustainable
5. To give education/formation to all publics a central role in the questionnaires related to threat on water resource.
6. To make this knowledge understandable to the most wide public
7. To make all public, from individuals to highest authorities, more sensible to accept the needed changes

We are the first generation (and the last one) that can make the changes. We cannot lose this opportunity. It is everybody’s task and everybody’s responsibility. We have all communication facilities for making COP21 a source of world’s hope not only for future climate based visions but also for building new human societies, where inter–connections can be much more acknowledged.
on expert judgement, and the other based on the method of Generalized Likelihood Uncertainty Estimation.

To consider the effect of climate change on the reservoir we simulated the hydrodynamic behaviour of Bimont under the projections obtained during the project CORDEX of three different regional climate models (RCMs) for each of the two emission scenarios RCP4.5 and RCP8.5. The projections used were those issued by the models HIRHAM5 and RACMO2, applied to the output of the GCM ICHEC–EC–EARTH; and by the model RCA4, applied to the output of the GCMs ICHEC–EC–EARTH, CNRM–CERFACS– CNRM–CM5 and MOHC–HadGEM2–ES. We considered two time horizons, a medium term (2036–2065) and long term (2066–2095).

We also considered different management options to see which the potentialities of adaptation to climate change are by varying water level, the temporal distribution and quantity of flow through the reservoir, and the outlet depth.

Water temperatures in the reservoir of Bimont are expected to increase during the present century, both in the epilimnion and the hypolimnion. The stratification period will likely become longer. The elevation of the water level results in similar surface water temperatures, and slightly lower hypolimnion temperatures. Some modifications of the reservoir management that have been suggested that can be more important than those of climate change.

According to the fourth national report on the implementation of the Convention on national biodiversity of March 2009, the known marine biodiversity amounts to 3183 species of which 3080 were confirmed after 1980. The marine flora is estimated at 713 species grouped in 71 genera and 38 families. If we add the coastal and island vegetation, marine and coastal bird life, the known total biodiversity of the Algerian coastal marine ecosystem is 4150 species, of which 4014 are confirmed for a total of 950 genera and 761 families. But it should be noted that these numbers do not reflect actual biodiversity but rather the known.

Through this contribution we will present aspects of the consequences of global warming on marine ecosystems and particularly on coastal and marine biodiversity and actions taken by Algeria to remedy this situation.

Impact of climate change on marine and coastal biodiversity: the case of Algeria
O. Rouane Hacene (1)
(1) University of Oran 1, Laboratoire Réseau de Surveillance Environnementale (LRSE), Department of Biology, Oran, Algeria

Known for its arid and semi-arid climate, Algeria is highly prone to climate change. The last 50 years, an increase of events with extreme weather has been observed. Among the phenomena recorded in Climate Studies of the National Meteorology that reflect this change, we observe an increase in the frequency of torrential rains, especially in the high ridges, which led to flooding for the first time. Other extreme events that have occurred: cyclogenesis, drought, heat wave and sand storms. Scientists have estimated that rainfall will decrease by about 20 percent in the coming years. They predict a shortening of the rainy season and higher temperatures of about 1° to 1.5° in 2020, which would have fatal consequences for 30 percent of animal species. They also feel that temperatures will rise by 3° C by 2050 due to global warming.

The flora and fauna (terrestrial and marine) have been greatly affected by this increase; the changing environmental conditions are favorable and/or unfavorable to certain environmental factors compared to others, which causes a change of environments and species of flora and fauna that constitute them.

Thus, the coastal areas were severely affected by the climate change. Today, it is permissible, in the light of the available scientific data, to associate with threats to marine biodiversity three important parameters and determinants of climate change: (i) the warming waters, (ii) the elevation of the sea level, (iii) water acidification. These changes will surely have consequences on the long-term on living marine communities in various ways. Especially that the Algeria includes a rich faunistic and floristic diversity.

An epidemiological assessment of stomatal ozone fluxes-based Critical Levels for Southern European forests
P. Sicard (1); A. De Marco (2); L. Dalstein-Richier (3); E. Paoletti (4)
(1) CNR-HE, Environment, Sophia-Antipolis cedex, France; (2) Italian National Agency for New Technologies, Energy and Sustainable Economic Development, Rome, Italy; (3) GIEFS, Nice, France; (4) Consiglio Nazionale delle Ricerche, Istituto per la protezione sostenibile delle piante, Florence, Italy

The Mediterranean Basin is expected to be more strongly affected by ongoing climate change than most other regions of the earth as a result of the regional geographic position. Northwestern Italy can be considered as case study for assessing global change impacts on forests. Southern forests are at the highest O3 risk in Europe where ground-level O3 is a pressing environmental threat to human health. Exposure-based standards for protecting vegetation are not representative of actual field conditions. A biologically-sound stomatal flux–based standard has been proposed, although critical levels for protection still need to be validated. This innovative epidemiological assessment of forest responses to O3 was carried out in 54 plots in Southeastern France and Northwestern Italy in 2011 and 2013. Three O3 indices, namely the accumulated exposure AOT40, and the accumulated stomatal flux with and without an hourly threshold of uptake (POD1 and POD0) were compared. Stomatal O3 fluxes were modelled (D033E) and correlated to exposure-based indices, i.e. crown defoliation, crown discoloration and visible foliar O3 injury. Soil water content, a key variable affecting the severity of visible foliar O3 injury, was included in D033E. Based on flux–effect relationships, we derived species-specific exposure-based (CLeC) and flux–based critical levels (Clef) for forest protection, by joining data from all plots and years. As AOT40 was better correlated with defoliation than with damage to visible injury, we selected defoliation as effect parameter for defining AOT40-based CLeC values. As a tree with defoliation above 25% is commonly rated as damaged, CLeC was calculated on the basis of the threshold of 25% average stand defoliation. As POD0 was better correlated with visible foliar O3 injury than with defoliation and discoloration, we selected visible foliar O3 injury as effect parameter and POD0 as O3 metric for defining D033E– based Clef values. Unfortunately, a definition of damaged tree/stand based on visible foliar O3 injury is missing in...
the literature. We thus based the selection of a visible follar O3 injury threshold on a comparison of gas exchange of leaves with a range of visible O3 injury that was carried out in a 3-year-old O3-sensitive poplar plantation. CLEf was derived from flux-effect functions for 15% of visible foliar injury (stand level). We obtained CLeF of 11.7 ppm.h AOT40 for P. cembra (high O3 sensitivity) and 24 ppm.h for P. halepensis (moderate O3 sensitivity). For broadleaved species, the average CLeF was higher than for conifers (21.6 ppm.h AOT40) and similar in the two species with significant correlation between crown defoliation and AOT40, i.e. Fagus sylvatica (moderate O3 sensitivity) and Fraxinus excelsior (high O3 sensitivity). For conifers, CLeF of 19 mmol.m-2 for P. cembra and 24 mmol.m-2 for P. halepensis were calculated. For broadleaved species, we obtained a CLeF of 21 mmol.m-2 for Fagus sylvatica and of 19 mmol.m-2 for Fraxinus excelsior. To avoid an underestimation of the real O3 uptake, we recommended the use of PODO calculated for hours with a null global radiation over the 24-h O3 accumulation window. We showed that an assessment based on PODO and on real plant symptoms is more appropriate than the concentration-based method. Indeed, PODO was better correlated with visible foliar O3 injury than AOT40, whereas AOT40 was better correlated with crown discoloration and defoliation (aspecific indicators).

In the current climate change context, a deterioration of the crown conditions was observed likely due to a drier and warmer climate. Clearly, if such climatic and ecological changes are now being detected when the climate, in Southeastern France, has warmed in the last 20 years (+0.46-1.08°C), it can be expected that many more impacts on tree species will occur in response to predicted temperature changes by 2100 (+1.95-4.95°C). Climate change will create additional challenges for forest management.

P-3326-13

Sea-level changes in the western Mediterranean during the last 12,000 years: a tool to better constrain the future projection of sea-level rise

M. Vacchi (1); N. Marriner (2); C. Morhange (3); G. Spada (4); A. Fontana (5); A. Rovere (6)

(1) Aix-Marseille Université, CEREGE CNRS-IRD UMR 34, Aix-en-Provence, France; (2) CNRS, Laboratoire Chrono-Environnement UMR6249, Université de Franche-Comté, Besançon, France; (3) Aix-Marseille Université, CEREGE CNRS-IRD UMR 34, Cerege, Aix-en-Provence, France; (4) Urbanino, University, Department of mathematics, physics and informatics, Urbino; (5) Università di Padova, Dipartimento di scienze della terra, Padova, Italy; (6) MARUM, ZMT, University of Bremen, Bremen, Germany

Global sea-level rise is the result of an increase in the ocean volume, which evolves from changes in ocean mass due to melting of continental glaciers and ice sheets, and the expansion of ocean water as it warms. The elevation of the ocean surface relative to the geoid, which is defined as a relative sea level (RSL), and any shift in height of either of these two surfaces produces a RSL change. Present-day sea level variations in the Mediterranean depend on various factors, including recent climatic forcing, tectonic activity, anthropogenic effects, and glacio-isostatic adjustment. Our understanding of current rates of sea-level rise from tide gauge and satellite data, requires correction for glacial isostatic adjustment. Sea-level histories in 21 regions located in Spain, France, Italy, Malta, Tunisia, Slovenia and Croatia. At the basin scale, RSL rose rapidly from 12.0 to 6.0 ka BP. Younger data showed a significant decrease in the rising rates in the last 6.0 ka. During the last Holocene (last 4.0 ka BP) GIA, sediment compaction and local neotectonic activity played a major role in controlling sea-level variability between regions. Data showed that sea-level was higher than today only in Tunisia.

Preliminary comparison with long-term tidal gauge data (>50 years) indicates an increase in rates of sea-level rise during the last 100 years.

Results of this study are relevant for understanding how GIA operates in the far field of late-Pleistocene ice sheets and to assess sea level rise hazards, which are particularly magnified in low-lying or subsiding coastal areas.

3327 - Adapting to Arctic Climate Change

ORAL PRESENTATIONS

K-3327-01

EU-PolarNet - Connecting Science with Society

N. Biebow (1); K. Lochte (2)

(1) Alfred-Wegener-Institut, Helmholtz-Zentrum fuer Polar- und Meeresforschung, International Cooperation, Bremerhaven, Germany; (2) Alfred Wegener Institute, Helmholtz Zentrum fuer Polar und Meeresforschung, Directorate, Bremerhaven, Germany

The rapid changes occurring in the Polar Regions are significantly influencing global climate with consequences for global O3 concentrations. EU-PolarNet research has contributed critical knowledge to identifying the processes behind these rapid changes but, in contrast to lower latitudes, datasets from the Polar Regions are still insufficient to fully understand and predict climate change. We propose a broadened view of the adaptation challenge facing the Arctic. Framing the results using Adger and Barnett’s (2009) ‘reasons for concern about adaptation’, we demonstrate that: (i) significant barriers are likely to constrain adaptation in absence of concerted action on climatic factors; (ii) significant barriers are likely to constrain adaptation in absence of concerted action on
broader human development deficits in northern regions. These barriers span multiple scales and are linked to long-term trajectories of disempowerment, colonization, and globalization; (iii) the potential for maladaptation is being increased by a weakening of key sources of adaptive capacity, compounded by limited anticipatory actions across scales to prepare for future impacts; and (vi) communities and indigenous organizations have played leading roles in adaptation decision-making in the North American context, but in Russia the very nature of climate change as a potential risk is not agreed upon. The challenge of adaptation in the Arctic is thus formidable, yet the review suggests that drivers of vulnerability can be overcome, avoided, or reduced by individual and collective efforts across scales.

O-3327-02

APECs France, a network of French early-career polar researchers involved in education and outreach activities

P. Bourgain (1); AM. Thierry, (1); G. Lamarque, (1); C. Clement-Chastel, (1); M. Lacarra, (1); Z. Koenig, (1); F. Amélineau, (1); S. Serre, (1); X. Meyer, (1); Y. Drocourt, (1); M. Gesta, (1); LPAC. Bilan (1)

(1) APECs France, Grenoble, France

APECs–France (www.apecs-france.org), the French national committee of the Association of Polar Early Career Scientists (APECs), is a young organization of volunteers created in 2013. Its objectives are to promote early-career polar scientists and to improve the dissemination of polar sciences towards the general public and school children in particular. APECs–France has developed several activities, projects and partnerships to better educate French students about the polar regions, better explaining their importance in the context of global climate change. For instance, the French polar week is organized twice a year, and thousands of pupils can exchange with polar scientists about their research and their life as young scientists. Every December 1st, APECs–France collaborates with OurSpaces, British foundation for the good governance of international spaces, to celebrate Antarctica Day, connecting young students to the French research polar station Dumont d’Urville in Antarctica. Schools are also involved to follow scientific expeditions: such long-term education and outreach projects imply resources for teachers, a blog, visits in classrooms, and/or oceanographic data analysis. APECs–France is now planning to edit a children’s book using students’ drawings and photographs taken during the PAX Arctic – On the Shoulders of Shackleton Expedition. More recently, APECs–France has developed a partnership with Wild-Touch (French non-profit organization created by Luc Jacquet, director of March of the penguins) and CriWild-Touch (French non-profit organization created by Clément-Chastel, (1) Gesta, (1); LPAC. Bilan (1)

The global economic implications of the melting of the Greenland ice sheet

Mj. Alvarez (1); D. Yumashev (1); G. Whiteman, (1); J. Wilkinson (2); P. Wadhams (3); C. Hope (4)

(1) Erasmus University Rotterdam, Rotterdam, Netherlands; (2) British Antarctic Survey, Cambridge, United Kingdom; (3) University of Cambridge, Cambridge, United Kingdom; (4) University of Cambridge, Judge business school, Cambridge, United Kingdom

The Arctic has been changing at unprecedented rates over the past two decades, with the average rate of warming in the region roughly twice as high as the global average (IPCC, 2014). According to the 5th Assessment Report by IPCC (2013), there is growing evidence that Arctic change may have far-reaching consequences across the globe. Yet the potential global economic impacts from specific physical changes in the Arctic region are largely unstudied (Whiteman et al., 2013). This paper contributes to this emerging research agenda by assessing potential economic impacts from the Greenland ice sheet (GIS) using the PAGE integrated assessment model (IAM), one of the top three IAMs used for climate change policy analysis and estimation of economic impacts related to climate change. While integrated assessment models (IAMs) have been used to estimate future economic impacts of Arctic change has thus far only been applied to potential methane release in the East Siberian Sea (Whiteman et al., 2013).

IAMs are simplified representations of key relevant systems such as “emissions and their socioeconomic determinants, the atmosphere–ocean–climate system, ecosystems, socioeconomic impacts, and policy and responses” (Parson and Fisher-Vanden, 1997). To date, IAMs (including PAGE), do not directly incorporate physical change into model configurations, but rather rely upon temperature estimates. Thus, uncertainties such as sea level rise from increased melt of the Greenland Ice Sheet (GIS) do not directly feed into the IAM structures. Current and future changes in GIS carry significant implications for the environment and for the global economy. To address this gap (and as part of the ICE-ARC project[1]), we adopt a transdisciplinary approach to adapt PAGE in order to evaluate the economic impact of different scenarios of GIS change.

More specifically, in this paper we (i) propose model modifications to integrate the physical changes in the GIS explicitly into the PAGE IAM, and (ii) identify how best to assess economic impacts (costs and benefits) resulting from it. This includes looking into the potential drivers of the GIS melt – such as overall Arctic warming and black carbon pollution from the increasing wildfires (Benning et al., 2014; Doherty et al., 2013) as well as the main mechanisms by which the GIS melting will cause economic impacts globally. These include: sea level rise (which highlights the need to de-couple the GIS and Antarctic Ice sheets in the PAGE sea level rise module), changing atmospheric and ocean circulations and its effect on weather patterns in Europe, North America and further afield. In order to achieve this, we develop distinct scenarios for the GIS melt under a given RCP (global emissions scenario) and work out the relevant economic costs globally using PAGE–ICE. References: Benning et al., (2014); Hope, C. (2011), The PAGE09 integrated assessment model: A technical description, Cambridge Judge Business School Working Paper, 41(1)/Hope, C. (2013), Critical issues for the calculation of the social cost of CO2: why the estimates from PAGE09 are higher than those from PAGE2002, Climatic Change, 117, 3, Pages 531–543/IPCC (2014), Climate change 2014: synthesis report. 5th Assessment Report. IPCC, Nordhaus, W.D. (2006), A question of balance weighing the options on global warming policies, Yale University Press/Parson, E., Fisher-Vanden, K. (1997), Integrated assessment models of global climate change, Annu. Rev. Energy Environ. 22, 589–628/Whiteman et al., 2007)
K-3328-01

Why is socially-just climate change adaptation in sub-Saharan Africa so challenging? A review of barriers identified from empirical cases

S. Shackleton (1); G. Ziervogel (2)
(1) Rhodes University, Environmental Science, Grahamstown, South Africa; (2) University of Cape Town, Department of environmental and geographical sciences, Cape Town, South Africa

To enhance understanding of the process of climate change adaptation and to facilitate the planning and implementation of sustainable adaptation strategies, deeper consideration of the factors that impede adaptation is required. Barriers to climate change adaptation are, consequently, being increasingly reported. But, despite this progress, knowledge of barriers that hamper adaptation in developing countries remains limited, especially in relation to underlying causes of vulnerability and low adaptive capacity. To further improve understanding of barriers to adaptation and identify gaps in the state-of-the-art knowledge, this paper presents a synthesis of empirical literature from sub-Saharan Africa focusing on vulnerable, natural resource dependent communities and livelihoods. Our review illustrates that: 1) local level studies that reveal barriers to adaptation are diverse, although there is a propensity for studies on small-holder farmers; 2) many of the studies identify several barriers to adaptation, but appreciation of their interactions and compounded impacts remains scarce; and 3) most of the barriers uncovered relate broadly to biophysical, knowledge and financial constraints on agricultural production and rural development. More hidden and under-acknowledged political, social and psychological barriers are rarely mentioned, unless captured in studies that specifically set out to investigate these. We argue that research on barriers needs to start asking why these barriers emerge, how they work together to shape adaptation processes, who they affect most, and what is needed to overcome them.

K-3328-02

E. Madela-Mntla (1)
(1) ICsu Regional office for Africa, Pretoria, South Africa

Background: Africa occupies a unique position when it comes to Climate Change challenges. It is one of the most vulnerable continents yet has very limited capacity for adaptation and recovery. Some of its challenges owe to its poor economic and social developmental states. A brief illustration of this:

According to the UN Office of The High Representative For The Least Developed Countries, Landlocked Developing Countries And Small Island Developing States (UN– OHRLSS), of the 48 Least Developed countries (LDCs), 34 are in Africa, of the 31 Landlocked developing countries (LLDCs), 15 are in Africa; and of the 39 Small Island Developing States (SIDS), 8 are in Africa. Africa

Climate Change challenges that accompany this situation include those associated with sea-level rise and changes in coastal and marine resources, which have very serious consequences particularly for SIDS, biodiversity and ecosystems changes, which have a negative impact on tourism, food security and other socio–ecosystems services; frequent and severe natural disasters like mudslides, floods, droughts and veld fires; poor infrastructure, leading to high transportation and communication costs.

The ultimate result of these challenges is a ripple effect on health and human well-being, availability of land and water resources, management of waste, renewable energy options, infrastructure choices as well as national finances. Resilience declines, mortality rates go up, life expectancies decline and ultimately sustainable socio-economic development is retarded. Needless to say, some countries in Africa have a fair level of development, but these are not immune to some of these regional impacts of climate change. The cost of adaptation rises by the day in a region already facing many challenges like poverty. The IPCC 2007 Report estimates that the cost of adapting to climate change in Africa could amount to at least 5 to 10% of Gross Domestic Product (GDP), and other projected impacts like increased water stress, reduction in yields from rain-fed agriculture, as well as an increase in arid and semi-arid land could worsen in the next few years (Report. Summary for Policy Makers, IPCC, 2007). Considering the scale of poverty for most African populations, adaptation is costly, it’s about survival.

Call for Concerted Action: Africa is generally reported as one of the least environmental polluters because of its low industrial development. However, it stands to suffer dire consequences from the effects of climate change. Information available points to evidence that all sectors will be generally affected. Why then, you may ask, is there no or poor concerted response to mitigate the impacts. We take a closer look at the key role players on the continent and how their collaborative efforts could positively impact Africa’s climate change mitigation and adaptation attempts.

O-3328-01

African Climate Change Challenges: Innovative Climate Adaptation Practices in Ghana

A. Yeboah Obeng (1)
(1) Foresight Generation Group, Environment and Ecosystems Division, Cantonments – Accra, Ghana

INTRODUCTION
Recent studies by IFPRI suggest crop yields across sub-Saharan Africa may decline 5–22% by 2050, pushing large numbers of people deeper into hunger and poverty as both of Africa’s staple crops, maize and sorghum, are expected to be badly hit by increasing severe weather.

Climate Change and its adverse impacts is been felt across many regions of Ghana and also in the majority of ACP states, this project has been under implementation since 2012 particularly as a solution to the visible effects and impacts of erratic climatic patterns affecting cropland and animal production in catchment communities in Ghana whiles encouraging environmentally friendly practices by farmers, also this project seeks to promote innovative ICTs and climate driven agricultural practices and policies which has successfully increased agricultural productivity and profits in catchment communities and have proved to be very resilient to climate change on agriculture for the targeted farming communities thereby improving food security in the project’s catchment towns in Ghana and replication prospects in other African countries.

DESCRIPTION
ITU data suggest that mobile penetration reached 84.8 per cent in 2011, compared with fixed line penetration of 1.14 per cent, although the number of individual subscribers may be lower than that in practice, also mobile network coverage is not uniform across Ghana as areas that lack coverage are typically those with small population centers, which cannot economically support the installation of a base station. Ghana’s mobile networks were in the past was predominantly second generation (2G) GSM technology which did not provide data connectivity however there has been major upgrade to faster third generation (3G) technology which has enabled both citizens and businesses to enjoy the enormous benefits of faster mobile telephone and data services across Ghana.

BEST CLIMATE CHANGE ADAPTATIONS PRACTICES INAGRICULTURE
Setting up virtual online farmer association meetings – to enable farmers with different farming towns and communities to communicate and exchange problems and the problems they have been facing in their villages, access to financing, new agricultural practices and new innovative
Scaling up adaptation in Africa - barriers and enablers

P. Urquhart (1)

(1) Independent researcher, Cape Town, South Africa

A critical question as the adaptation discourse and practice matures in Africa relates to how to scale up adaptation in a way that is sustainable, and promotes social justice goals. A relevant point concerns the types of transformations that are needed across processes to support and scale up sustainable adaptation. There is no doubt that governance institutions at different levels have a decisive role to play in the role of poorly adapted and fragmented institutional frameworks and overall low levels of adaptive capacity, especially competency at local government level, to manage complex socio-ecological change. Structural poverty and inequity are common found many countries. Despite these circumstances, the local context for adaptation differs not only between countries, but between sub-national regions and indeed within localities, for different groupings of people. So how can we begin to identify the kind of steps needed on the transformation pathway? The IPCC 5th Assessment Report identified a number of key principles for building adaptive capacity and climate resilience, based on extensive assessment of the academic and grey literature, on adaptation in Africa. The principles point to necessary changes in policy and practice, and to the role of adaptive management and social and institutional learning as a way to scale up adaptation. This presentation will examine the potential of these principles to play a role in overcoming key barriers towards scaling up sustainable adaptation in Africa, and raise questions for discussion on the social and process dimensions of enabling scaling up.

3328-POSTER PRESENTATIONS

P-3328-01

Welfare impacts of climate shocks: evidence from Tanzania and Uganda

A. Arslan (1) ; S. Asfaw, (1) ; F. Belotti, (2) ; A. Piano-Mortari, (1) ; L. Lipper, (1) ; P. Karfakis (1) ; L. Ciccone, (1)

(1) FAO of the UN, Agricultural Development Economics Division, Rome, Italy; (2) University of Tor Vergata, Cēs, Rome, Italy

Sub-Saharan Africa (SSA) remains the world’s most food-insecure region characterized by high levels of child mortality and poverty and low levels of human & physical capital (FAO, 2009). SSA countries, including Tanzania and Uganda, are predominantly smallholders and subsistence farmers. Due to the importance of food crops and livestock to smallholders and subsistence farmers in SSA, we use nationally representative household data together with a set of novel weather variation indicators based on interpolated gridded and re-analysis weather data that capture the peculiar features of short term and long term variations in rainfall and temperature. In particular, we estimate the impact of weather shocks on a rich set of welfare indicators (including total income, total expenditure, food expenditure, food expenditure share in total expenditure, calorie intake for the household) and investigate whether and how they vary by different definitions of shocks. Moreover, we also analyze the interactions of these climate risk welfare relations with a set of relevant variables such as access to extension information, access to credit and the use of sustainable land management (SLM) practices, which may help farmers to cope with risk and smooth income (Morduch, 1995).

Our results show that both rainfall and maximum temperature variability (defined for the last 25, 10, 5 and 3 years) exert a negative impact on welfare. Wealth quintile results vary according to the reference period with respect to which the indicators are computed. Our estimates also show a significant income-smoothing for households that have adopted SLM practices. The findings suggest that SLM may serve as a potential ex-ante risk coping strategy. We also find that the most vulnerable rural households are much more negatively affected by a rainfall deficit compared to the households in the top income quintile. We compare and contrast the results from Tanzania and Uganda to draw site-specific and evidence-based policy implications to improve welfare outcomes under increasingly unpredictable weather conditions in these countries.

P-3328-02

The African Safe Water Supply Challenges: Moringa Technology as an Alternative Approach

A. Bashir Yusuf (1)

(1) AHMADU BELLO UNIVERSITY, ZARIA, BIOLOGICAL SCIENCES, ZARIA, KADUNA, Nigeria, Federal Republic of

Water is one of the most important indicator of climate change today. This is seen in the two extremes of water supply, either being short through erratic rain spells affecting consumption and agricultural needs or excessive supply through flooding. In traditional African rural settlement, water for human consumption during the rainy season in particular is highly turbid with the consequence of water-borne diseases. “In the developing world, more than 1 billion people cannot get clean drinking water... The United Nations says that dirty water causes 80 percent

systems and practices including market information and latest price and weather forecasts. Remote col-laboration and applications of ICT’s for virtual interactions will significantly reduce greenhouse gas emissions caused by travel. 0.5 billion tonnes CO2e can be saved without any major investments.

Agriculture e-commerce – we have successfully assisted farmers to sell their farm produce through selected Messaging applications on mobile devices of farmers and that of our project field teams assisted farmers to be in touch with buyers of their farm produce without the need for the farmers to travel long distances to sell their foods at nearby marketing centers. By this online transaction fuel usage and emission by vehicles have been saved and time and money have been saved for the farmers using this service depending on uptake, these solutions can avoid more than a billion tonnes of CO2e.

In countries where agricultural sector is largely based on small-holders and dominates the economy, the main linkages between weather and incomes go through agriculture, and when the latter is based on rain-fed subsistence agriculture, this link also has substantial implications for food security and welfare. Since climate change exacerbates weather fluctuations translate into income shocks especially faced by small-holders, not only are the average incomes low but also they are highly volatile. In addition to the important policy implications of climate shocks, and enablers for the farmers to travel long distances to sell their foods touch with buyers of their farm produce without the need for the farmers to travel long distances to sell their foods at nearby marketing centers. By this online transaction fuel usage and emission by vehicles have been saved and time and money have been saved for the farmers using this service depending on uptake, these solutions can avoid more than a billion tonnes of CO2e.

In countries where agricultural sector is largely based on small-holders and dominates the economy, the main linkages between weather and incomes go through agriculture, and when the latter is based on rain-fed subsistence agriculture, this link also has substantial implications for food security and welfare. Since climate change exacerbates weather fluctuations translate into income shocks especially faced by small-holders, not only are the average incomes low but also they are highly volatile. In addition to the important policy implications of climate shocks, and enablers for the farmers to travel long distances to sell their foods touch with buyers of their farm produce without the need for the farmers to travel long distances to sell their foods at nearby marketing centers. By this online transaction fuel usage and emission by vehicles have been saved and time and money have been saved for the farmers using this service depending on uptake, these solutions can avoid more than a billion tonnes of CO2e.
of diseases in the developing world, and kills 10 million people annually. While similar water supply during the same season in urban centers is difficult to treat by water works departments since they depend on the clarification by importing aluminium sulphate. However, the existence of a natural coagulant from Moringa seed holds promise as a substitute to the chemical coagulant of alum. The practice of using Moringa seed in water treatment has been scientifically proven both at small household and large community scales. Local varieties of Moringa from Nigeria have been shown to contain 18-20% cationic protein (MOPC) that is active on coagulation and against common bacteria and viruses in untreated water. MOPC act on microbes by fusing their inner and outer membranes affecting exchange within and outside their cellular component. This paper highlights role of the Moringa seed technology in water treatment as a substitute to aluminium sulphate with the potential of portable safe drinking provision in Africa and other developing nations.

P-3328-03
Harnessing the multidimensional climate and non-climate signals to livelihood vulnerability and adaptive capacity in Kaffrine, Sénégal

A. Diouf (1); C. Mbom (1)
(1) Institut des Science de l’Environnement, Faculté des Sciences et Techniques, Dakar—Senegal, Senegal

The increase of rainfall variability has since the beginning of the 1970s, one of the common threats of semi-arid countries with rapid and strong anomalies and extreme events. Kaffrine is one of those areas facing these rapidly dynamic climate challenges that affect both productive systems and populations income. The history of this site exhibits a long lasting domination of groundnut production for cash and high dependence to forest resources for income and mostly as a livelihood asset. Both groundnut cultivation as a rain fed crop and forest resources access are exposed to climate variability, but the magnitude of the climate drivers has not been fully accounted systematically in assessing vulnerability and subsequently developing adaption strategies that are context specific.

With the increasing local empowerment through devolution of natural resources management, many policy decisions are undertaken for sustainable development and socioeconomic resilience at community level. Accounting for the real weight of climatic factor on livelihood dynamics can help better understand the essential variables or drivers for adapting to co-design proper options for improved resilience in Kaffrine. The research question is how to set a series of criteria and climate indicators that help understand the real climate impact and how productive systems respond to that. The central hypothesis is how to set a series of criteria and climate indicators to co-design proper options and climate derivatives of vulnerability to co-design proper options that can help better understand the essential variables or drivers for improving resilience through the diversification of livelihoods.

Climate change is one of the most serious threats the world faces. It will affect all of us, but will have disproportionate impacts on millions of poor rural people in Ethiopia. For development to be effective, we must help poor rural people emerge from poverty, we must enable them to cope with and mitigate the impact of climate change. Agriculture is the human enterprise that is most vulnerable to climate change because of the subsistence nature of the farming practices, and because communities have little resources to adapt to the impacts of climate change. Farmer’s adaptive capacity is constrained by a lack of economic and technical resources, and they are vulnerable due to a heavy dependence on rain-fed crops. While agro forestry may play a significant role in mitigating the atmospheric accumulation of greenhouse gases (GHG), it also has a role to play in helping smallholder farmers

The paper examines the demographic and socioeconomic characteristics of rural farming communities as determinants of vulnerability and adaptation to climate change in the Nigerian Savannah. The Nigerian savannah has been seriously affected by human activities which have reduced its capacity to support the teaming rural farming communities and livelihood systems. The fact that livelihood systems in the region are closely tied to terrestrial ecosystems and changes in global climate functions are major issues in their conditioning. The demographic and socioeconomic characteristics of selected agricultural communities in the Nigerian Savannah were examined with the view to assessing their vulnerability and adaptive capacities. The methodology for the study was based on multistage random sampling technique and Rural Rapid Appraisal (RRA) of 11 communities across 10 Local Government Areas (LGAs) in two states (southeast and northwest) of Nigeria. Site visits, Key Informant Interview of traditional rulers and Government officials were carried out while an intensive Focused Group Discussion among all the actors was done. The role of education, income from farm and other sources, ability to diversify, willingness to adapt, proportion of savings, and local adaptation mechanisms were identified and used to examine the relationship between indicators of vulnerability and adaptation of local farmers and communities to climate change in the region. By matching indicators of vulnerability and factors of local adaptation it help the understanding of local actions, barriers to adaption, present and future capacities.

The gender, age, marital status and size of households of the respondents reveal that local farming communities have large family sizes, low education and incomes from predominantly farming activities (65.8%). These conditions could perpetuate poverty and predispose rural farmers to poor health which in turn cause higher food insecurity, as well as access to education, health and other social services. This would further exacerbate the conditions of the rural farmers. One of the important questions arises, to what extent would environmental and climate change impacts which could also limit adaptation. However, the paper analyse the opportunities to make money from other sources which shows that they could be protected from unexpected shocks from climate change and increase their resilience through the diversification of livelihoods. The poor culture of savings in these communities which cannot be divorced from their poor incomes from farm–based activities could limit adaptation. The results shows that the farming communities are facing the realities of climate change with 30% of the sampled population involved in adaptation while 21.9% are not. Some of the adaptation methods include use of fertilizer to boost production, shifting cultivation and irrigation while 17.2% do not know what to do. The farming communities deploy irrigation and organic farming, irrigation and rain harvesting and hiring of labor as means of improving farming activities. The paper suggests that there should be a rural development policy to increase opportunities and prospects of non-farm activities and promote the culture of savings in these communities. The idea is to build the capacity of the farming communities to support the farming communities to climate change and improving farm activities must be developed sustainably to reduce vulnerability and ensure rural adaptation. This should engage the interest of policy makers if poverty eradication at worst reduction is a sincere aspiration for the region.

P-3328-05
Climate Change Adaptation and Mitigation through Agro forestry systems in Wolaita Zone, Southern Highland of Ethiopia, East Africa

W. Haileslassie (1)

Climate change is one of the most serious threats the world faces. It will affect all of us, but will have disproportionate impacts on millions of poor rural people in Ethiopia. For development to be effective, we must help poor rural people emerge from poverty, we must enable them to cope with and mitigate the impact of climate change. Agriculture is the human enterprise that is most vulnerable to climate change because of the subsistence nature of the farming practices, and because communities have little resources to adapt to the impacts of climate change. Farmer’s adaptive capacity is constrained by a lack of economic and technical resources, and they are vulnerable due to a heavy dependence on rain-fed crops. While agro forestry may play a significant role in mitigating the atmospheric accumulation of greenhouse gases (GHG), it also has a role to play in helping smallholder farmers
adapt to climate change. This paper presents data that examined the adaptation and mitigation of different agro forestry systems. Hence, the research questions those need to be answered concerning the role of agro forestry in both mitigation and adaptation to climate change. It is recommended that in low-income and food-deficit regions livelihoods including food security and climate change cannot be tackled in isolation.

P-3328-06

Responding to the Scares Skills Needs in the Renewable Energy Domain in South Africa

Y. Hamam (1); L. Makhubela (2); AM. Kurien (3)
(1) Tshwane University of Technology, Department of Electrical Engineering, Pretoria, South Africa; (2) Tshwane University of Technology, Post graduate studies research and innovation, Pretoria, South Africa; (3) Tshwane University of Technology, F’sati, Pretoria, South Africa

According to the South African department of Energy, almost 90% of South Africa’s electricity is generated in coal-fired power stations. One nuclear station near Cape Town produces about 5% of the total capacity. The remaining 5% is provided by hydroelectric and pumped storage schemes, the sites available for this power being limited. The French universities of technology (TUT) in Pretoria, South Africa is responding to these needs in collaboration with French and European Institutions.

This is done through institutions within the Faculty of Engineering and the Built Environment:

• The French South-African Institute of Technology (F’SAT)
• The Centre for Energy and Electric Power (CEEP)

These institutions collaborate within the graduate programme of the Department of Electrical Engineering to provide courses and research in the energy domain and specifically in the renewable energy specialisation.

F’SATI is a National asset contributing to the creation of knowledge and the transfer of technology in South Africa through the establishment of collaboration between various higher education and research institutes, as well as industry. F’SATI’s mission is to improve the quality and the quantity of the output at postgraduate level. This proposition is enhanced through collaboration with other French partners. In the last four years F’SATI has highly increased its output at both postgraduate students and publication levels. The present stakeholders of this venture are the French Ministry of Foreign Affairs, the French Ministry of Education and Research, The Chamber of Commerce an Industry of the Parisian region, the South African Department of Science and Industry and National Research Foundation.

The European partners of the CEEP include the Hogeschool Utrecht University of Applied Sciences, the University of Utrecht, the ECOPYS, the RWTH-Aachen University and the French ESIEE-Amiens.

The partners of the above programmes include companies such as ESKOM the main power company, Local Municipalities, the Council for Scientific and Industrial Research (CSIR) and other South African Universities.

The above programmes have contributed to the training and education at both the Masters and Doctorate levels. These programmes cover the following domains: smart networks, photovoltaic applications, wind energy production as well as hydropower. This collaborative effort has resulted in the training of postgraduate students as well as the production of many scientific publications in the domain of renewable energy.

The graduates of these programmes contribute to the development of renewable energy in South Africa. This adventure is a small sample of a collaboration between European countries and an African country. It shows that such a venture may respond to scarce skills that are highly needed in Africa.

The authors will give more details of these activities in the full document and the oral presentation.

P-3328-07

The Nexus of Climate Downscaling Using RegCM4 and Hydrology dynamics in Ghana

R. Kasei (1)
(1) University for Development Studies, Climate Change and Food Security, Tamale, Ghana

Climate Downscaling is a term adopted in climate science in recent years to describe a set of techniques that relate local to regional-scale climate variables in relation to the larger scale atmospheric forcing. Theoretically, the techniques are advancements of the known traditional techniques in synoptic climatology. Climate downscaling specifically addresses the detailed temporal and spatial information from Global Climate Models (GCM) required by precise researches of today. The Regional Climate Model version 4 (RegCM4), with horizontal resolution of 55 km, was used to downscale the ECHAM5 simulations forced with observed SSTs over Ghana. This was done for the period January-June 1961–2000. The northern part of the basin is most vulnerable to these variations because it has a monomodal rainfall pattern compared to the south which has relatively higher rainfall amounts due to its bi-modal rainfall pattern.

The SPI analysis conducted on projected precipitation based on RegCM’s A1B and B1 scenarios against the base period of 1961–2000 showed both scenarios agreeing to a general drying trend for the future. Results show that precipitation will decrease by 10% to 70% in some areas during the long dry season will narrow, which may have extensive implications for agriculture and city water supply. In lieu of this, adaptation will be central to sustaining development and food security. The techniques are of paramount importance to this process. These include mainstreaming adaptation into policy planning processes at varied levels, enhancing water conservation for agriculture, promoting the cultivation of drought resistant and early maturing crop varieties, and promoting access to food through technical and economic infrastructure and services that facilitate food exchange.
P-3328-08
Risques Hydrométéorologiques dans les Villes Africaines RHYVA/PARRAF
A. Konaré (1)
(1) University Felix Houphouet Boigny, Laboratoire de physique de l’atmosphère et de mécanique des fluides, Abidjan, Ivory Coast

RHYVA Network: Risques Hydro-météorologiques dans le Villes Africaines

In synergy with the ECOWAS vision, the objective of RHYVA network is to develop a basic understanding of the risks in urban environments and to provide expertise to the communities at risk to share knowledge (results of the research, experience feedback, good governance practices, evaluation, coordination, communication and appropriate conduct). Make a plea and conduct training on disaster risk reduction at the subregional level.

P-3328-09
The role of indigenous knowledge systems in climate change, prediction, adaptation and mitigation in sub Saharan Africa
PL. Mafongoya (1) ; N. Chanza (2) ; C. Mubaya (3)
(1) University of KwaZulu Natal, Agriculture, Earth and Environmental Science, Pietermaritzburg, South Africa; (2) Nelson Mandela Metropolitan University, Department of geosciences, Port Elizabeth, South Africa; (3) Chinhoyi University of Technology, Resource mobilisation, Chinhoyi, Zimbabwe

The recognition of the significance of indigenous knowledge systems (IKS) has only begun to emerge at the international level in the last few years. Understanding the nature and relevance of IKS for climate change adaptation and mitigation is a new and expanding area of collaborating research involving indigenous people, local communities and scientist. IKS is the basis of community based observations of climate impact and traditional practices and mechanisms that provide a robust basis for climate change response. IKS can be defined as ecological knowledge or accumulative board of knowledge, practice and belief, evolving by adaptive processes and handed down through generations by cultural transmission about relationships of people with one another and their environment. For communities to adapt to climate change it is critical for them to perceive how climate is changing. Farmers have the following perception on climate change, shorting of growing season, changes in rainfall characteristics, increase in temperature, changes in wind characteristics and extreme events such as droughts, floods, dry spells, cyclones, etc. which increased incidence of pests and diseases. Farmers in Africa use indigenous knowledge systems for weather forecasting and prediction of season quality. They use a combination of tree phenology, animal behavior such as insects and birds and atmospheric phenomena such as the shape of the moon, type of clouds and wind direction. In most cases seasonal quality forecast and scientific forecast are identical. Scientific forecast may be able to complement indigenous forecast so as to mitigate the loss of traditional weather and climate indicators. Farmers use indigenous practices to adapt to climate change and mitigation.

P-3328-10
Responding to Sustainability Challenges in Irrigation Sector: Community-based Integrated ICT Solutions for Sub-Saharan Africa
H. Mongi (1) ; A. Mvuma, (1) ; A. Sife, (2)
(1) The University of Dodoma, Information Systems, Dodoma, Tanzania, United Republic of; (2) Sokoine University of Agriculture, Sokoine national agricultural library, Morogoro, Tanzania, United Republic of

Irrigation is the most water intensive sector, consuming nearly three quarters of global fresh water resources. Significant number of countries in Sub-Saharan Africa (SSA) are emphasizing on expansion of land under irrigation to offset food insecurity brought about by climate change and other factors. This is happening amid increasing evidences on declining fresh water resources in the same region, therefore triggering options to their sustainable management. This contribution highlights some technologies to enhance decision making, coordination and control in the community level as part of concerted responses to address sustainability challenges in the water sector, with the sustainability of water resources and relevant adaptation strategies to address sustainability. This contribution highlights some technologies to enhance decision making, coordination and control in the community level as part of concerted responses to address sustainability challenges in the water sector, with the sustainability of water resources and relevant adaptation strategies to address sustainability. This contribution highlights some technologies to enhance decision making, coordination and control in the community level as part of concerted responses to address sustainability challenges in the water sector, with the sustainability of water resources and relevant adaptation strategies to address sustainability. This contribution highlights some technologies to enhance decision making, coordination and control in the community level as part of concerted responses to address sustainability challenges in the water sector, with the sustainability of water resources and relevant adaptation strategies to address sustainability. This contribution highlights some technologies to enhance decision making, coordination and control in the community level as part of concerted responses to address sustainability challenges in the water sector, with the sustainability of water resources and relevant adaptation strategies to address sustainability.

P-3328-11
Impacts of climate change on water resources and relevant adaptation strategies in upper catchment of Pangani basin in Tanzania
S. Mwakalila (1)
(1) University of Dar es Salaam, Geography, Dar es Salaam, Tanzania, United Republic of

The climate change impact on water resources is the major challenge across the Pangani basin in Tanzania. In some areas, too little water leads to droughts and desertification, whereas in others too much water leads to increased flooding. The Tanzania Agriculture Policy advocates for integrated water and use of scientific forecast which can help the nation to achieve in improvement of food security; increasing farmer’s productivity and income. Following local peoples’ perception, the major climate change impact is drought (78%) with high frequency of occurrence. Irrigated agriculture which depends on water resources is by far the largest water use sector in Tanzania, is affected by changes in water availability that is caused by climate change. Climate change also alters irrigation water demand. Higher temperatures and more variable rainfall tend to increase water demand per unit of irrigated area. The adverse effects of climate change is felt by poor communities because of their low adaptive capacity associated with limited financial resources, poor infrastructure, low level of education, dependence on natural resources and lesser access to technology. Traditional irrigated agriculture is the most common adaptation strategy for crop production and account for more than 79% of the total irrigation schemes in the study area. Traditional irrigated agriculture which is the most common adaptation strategy for crop production and account for more than 79% of the total irrigation schemes in the study area. Traditional irrigated agriculture which is the most common adaptation strategy for crop production and account for more than 79% of the total irrigation schemes in the study area. Traditional irrigated agriculture which is the most common adaptation strategy for crop production and account for more than 79% of the total irrigation schemes in the study area. Traditional irrigated agriculture which is the most common adaptation strategy for crop production and account for more than 79% of the total irrigation schemes in the study area. Traditional irrigated agriculture which is the most common adaptation strategy for crop production and account for more than 79% of the total irrigation schemes in the study area. Traditional irrigated agriculture which is the most common adaptation strategy for crop production and account for more than 79% of the total irrigation schemes in the study area.
Conveyance canals are usually hand dug and not lined to minimize seepage. Because the canals are unlined, they quickly get clogged by vegetation growth which reduces their efficiency. The canals typically lack flow control devices for effective conveyance and distribution. This implies that traditional irrigation shall continue to wasteage of water sources from the source to the field level. Promotion of efficient irrigation water use and adoption of good farming practices is, therefore, critical to ensuring sustainable use and management of water resources for sustaining local peoples’ livelihoods in Tanzania. Since water demands have intensified with the increase of economic activities such as irrigated agriculture, hydropower generation, fisheries and wildlife activities, this paper recommends effective implementation of integrated water resources management as adaptation measure to be enhanced and implemented, to ensure sustainable use and management of water resources for sustainable development.

P-3328-12

Complementing Local Indigenous Knowledge and Practices and scientific knowledge for better policy planning on climate change adaptation: the Case of Cameroon

E. Ngang (1)
(1) Information and Communication University (ICT-U), Management, Yaounde, Centre, France

Climate change is a defining issue of our era, with its impacts reaching regional and global scales. The current magnitude and variability have critical implications for agriculture which is dependent on weather conditions, compositions, and essential ecosystem functions. Warming, combined with the higher risk of extreme floods and droughts, shrinking water resources will lead to the rapid increase in the list of potentially damaging impacts, from soaring food prices to famine and mass migration of species including humans and increase in conflicts over diminishing natural resources. Countries of the African continent are among the most vulnerable to climate variability and extreme, given that only 5% of their cultivated land is irrigated and food production is dependent mainly on rain-fed agriculture. How serious the repercussions will be, depends on how fast measures and strategies are adopted to facilitate coping with the extreme and inevitable conditions posed by climate change especially for grass root communities. Unfortunately, some of these agriculture-dependent areas are most vulnerable to negative effects of climate change are quite remote with improper coverage by scientific forecasting stations. The farmers in these areas have been more dependent on their own practices adapt to inevitable changes in climate. Through on-farm management and post-harvest conservation practices, they have used their wealth of local indigenous knowledge and practices (LIKPs) in the food production chain to enhance their food security. It has been observed that although LIKPs have been recognised as a resource, they have however been given a tokenistic consideration through the addition of a small portion of traditional ecological knowledge in decision making processes related to climate change while business is still done as usual. These traditional practices that have been linked to have some impact in climate and long-term extreme weather conditions, transferred orally and through mutual and collective on-farm learning on-farm learning and practices, from one decade to another and from generation to generation, remain unvalidated. This poster presentation shall highlight the conflict between traditional (indigenous) knowledge, which is contextual, localised and the western-scientific and bureaucratic (often top-down) method of management that finds it difficult to reconcile national planning with local action (bottom-up) within the framework of climate change adaptation. Focus shall be given also to the broad basket of climate change impacts on the 30 million inhabitants’ livelihood is hinged on agriculture and these communities have learned to use their LIKPs to adapt to inevitably changing conditions. The most acceptable levels of adaptation and resilience to climate change have not been defined across the board, this paper emphasises that reconciliations between LIKPs and western science is essential for policy formulation and implementation processes. This places local communities as co-creators of knowledge and practices that cushions them against climate risks, ensuring ownership and sustainability of policies and implementation strategies.

P-3328-13

Influence of Madden-Julian Oscillation (MJO) on Rainfall Variability over West Africa at Intraseasonal Timescale

C. Nang (1)
(1) Laboratoire de Physique de l’Atmosphere de l’Ocean, Ecole Superior Polytechnique (ESP), Dakar, France

Intraseasonal variability of rainfall over West Africa plays a significant role in the economy of the region and is highly linked to agriculture and water resources. This research study aims to investigate the relationship between Madden Julian Oscillation (MJO) and rainfall over West Africa during the boreal summer in the the state-of-the-art Atmospheric Model Intercomparison Project (AMIP) type simulations performed by Atmosphere General Circulation Models (GCMs) forced with prescribed Sea Surface Temperature (SST). It aims to determine the impact of MJO on rainfall and convection over West Africa and identify the dynamical processes which are involved in the forcing of these events. It also aims to examine the general skills in capturing its main characteristics as well as its influence on rainfall over West Africa. On the global scale, most models simulated an eastward propagating MJO signal with the eastward propagation of enhanced and suppressed convection similar to the observed. However, over West Africa the MJO signal is weak in few of the models although there is a good coherence in the eastward propagation. In addition, the ensemble average of models give better performance in reproducing those features. The influence on rainfall is well captured in both Sahara and Guinea region, as they are highly affected by the MJO signal. Over the Guinea coast shows strong convective phase is clearly associated with the African Easterly Jet (AEJ) which carries the cyclonic wave over coastal Ghana. In assessing the mechanisms which are involved in the above impacts the convectively equatorial coupled waves (CCEW) are analysed separately. The analysis of the longitudinal propagation of Kelvin waves at 850hPa and outgoing longwave radiation (OLR) shows that the CCEW are very weak and their extension are very limited beyong West African region. It was found that the westward coupled easterly Kelvin Rossby waves are needed to bring out the MJO-convecton link over the region and this relationship is well reproduced by all the models. However, Kelvin waves do not account for the overall impact of MJO signal on convection over West Africa. It has also been confirmed that it may be possible to predict the anomalous convection over West Africa with a time lead of 15–20 day with regard to Indian Ocean and AMIP simulations performed well in this regard.

P-3328-14

Adaptation and response to climate change, an opportunity for local development in Central Africa: case study of Cameroon western highlands

Dj. Nkue Nouwezem (1)
(1) University of Dschang, Geography, Dschang, Cameroon

Climate change offers opportunities for African countries to emerge. It calls the attention to a sustainable development in a century where African countries aspire to development, emergence and economic stability. According to observations made in different localities on the continent, African countries are trying to assess and mitigate the impact of climatic change with their own means. This will help them to address particular issues concerning them. Indeed, general measures proposed by stakeholders and policy makers based on them are not always the best to resolve problems arising. Besides, some are living in remote or rural areas and...
hence not aware of these mitigation measures and policies adopted. In Cameroon and especially in its western part, to ensure their productivity, farmers have ameliorated their production capacities by developing and mastering new production and commercialization tools. When talking about production we refer to the understanding of the new climatic patterns, the improvement of tilling and irrigation systems. Concerning commercialization, models have changed. Furthermore we see buyers going direct to the farmers. These goods from farmers a long time ago it was the producers who were going toward the buyers. Moreover, things have improved at the national level. Contrary to what was done during the last ten years, this elaboration of meteorological data through national television programs and newspapers shows a great progress in the African sub region. This meteorological data have a great impact on the daily lives of populations in the area. Also, state institutions such as ministries of environment and their respective departments, which control industrial production models and sanction those who pollute the environment helps in encouraging sustainable development. This paper shows how local communities in central African countries in general and in the western highlands of Cameroon in particular have adapted to climate change, showing how they respond to it in order to ensure their agricultural production in climatic variability circumstances and how this adaptation contributes to their development. The data presented in this paper are the result of a qualitative research based on the situation in Africa and its respective realities. These data reflect globally what is happening in most of central African countries.

P-3328-15

Biomass Economy in the Era of Politicization and Economization of Nature in Africa: A Case for Clean Energy Transition

AIS. Okoh (1)

(1) Benue state university, political science, Makurdi, Nigeria, Federal Republic of

Over the next 25 years, 600 million people in Sub-Saharan Africa will depend on biomass and waste for total primary energy demand when you exclude South Africa, it is 81.2%. Yet, biomass economy as a vital sector of the economy is not integrated into the national development plan of most states. Traditional biomass is mostly unplanned heightening depletion of resources. Africa will witness increases in biomass consumption in 2035 whereas in other regions will witness decreases. With business as usual scenario Africa consumption will rise with exponential population explosion leading to between 51% - 57% higher demands for biomass in 2035. With greenhouse gases reaching 400ppm, man-made climate change will be a barrier to attainment of Sustainable Development Goals (SDGs) of this generation putting an end to poverty. In 2030 however, ending global poverty is inextricably linked to energy consumption and production which will also exacerbate climate change. Resolving this complexity is critical in the years to come in that they are mutually reinforcing in Africa. In recognition, many countries made remarkable progress towards resolving this challenge by integrating renewable energy into the energy supply mix in the transition to zero carbon society. However, clean energy policies play vital role in creating clean economy as net zero emission and green growth are not just coterminous but axiomatic necessities. Yet, such necessity is also inter-related with our biospheric lifecycle. Clean energy consumption will be the first phase of the clean transition era to the future of low carbon civilization. For Africa, natural capital is still the large bowl for the transition to middle income country. I argue that though clean energy transition is the future to low carbon civilization. But for many countries in Africa biomass still holds more potential for improving economic wellbeing of the poor. Despite this, a decade of biomass extraction and gasification for power plants will magnify existing inequalities within the continent but will result in reversal of growth. It is my contention there are still many grey areas in clean economy as unsustainable exploitation of energy consumption with consequent consumption of the future reinforcing climate-related extreme events. This will require dramatic low carbon trajectory which aims at eco-efficient utilization of green infrastructure. And as such, it is a paradox of cohabiting extremes in the politicization and economization of nature in Africa.

In this paper, the above dilemma is closely examined in the light of its impediment to the food system and meeting SDGs. Finding an enduring energy policy solution to food insecurity will require an ecologically responsible food system that is not undermined by land grabs for biofuel production. Thus, this paper questions if Africa’s biomass economy made eco-efficient? In what ways has Africa’s energy policy mix changed with the politicization and economization of nature? Has Africa’s clean energy complex imbibed principle of allocative justice? Can policy reforms balance growth towards net zero trajectories? The answers to these questions shall be uncovered through secondary data sources which will point us towards proffering adjustments for 2030. Can Africa’s clean economy made eco-efficient? In what ways has Africa’s energy policy mix changed with the politicization and economization of nature? Has Africa’s clean energy complex imbibed principle of allocative justice? Can policy reforms balance growth towards net zero trajectories? The answers to these questions shall be uncovered through secondary data sources which will point us towards proffering adjustments for 2030.
African drylands. Agricultural productivity is however significantly constrained due to climate variability, low water supply, limited soil fertility and farmers’ remoteness from decision-making centres. In addition, future climate change is projected to further undermine agricultural productivity. Vulnerability is employed as a concept to capture the relation between farming systems and climate stresses impacting upon these systems. To promote learning for a food secure future, we present a quantitative and spatially-explicit typology of smallholders’ vulnerability in the drylands of Sub-Saharan Africa. This typology explicitly incorporates malnutrition as cause and consequence of vulnerability. We indicated the most relevant socio-ecological properties of dryland farming systems at a sub-national resolution including child malnutrition, water availability, soil erosion sensitivity, agropotential, income, population density, urban-rural population share, distance to markets and governance. Cluster analysis revealed nine typical patterns of vulnerability showing distinct indicator combinations. For example, one pattern depicts high levels of child malnutrition, a poor resource base and poor governance and is indicated in the hyper-arid to semi-arid areas of eastern Africa. This typology enables the evaluation of key inter-linkages between smallholders’ climate vulnerability and economic strategies. Strong social bonds are useful for the development of successful strategies for resilience building based on similarities among the farming systems and supports the identification of entry points for managing transitions towards a secure food future. The results contribute to strengthening the wellbeing of populations, particularly women and children, to enable climate change adaptation, which is inherently local and bottom-up and participatory. Lack of socio-ecological patterns enable new insights into the prioritisation of interventions to improve and monitor food security.

P-3328-18

Barriers and enablers to climate change adaptation in four South African municipalities, and implications for Community Based Adaptation

M. Spires (1); S. Shackleton (2)
(1) Rhodes University and ICIPE Africa, Grahamstown and Cape Town, South Africa; (2) Rhodes University, Environmental Science, Grahamstown, South Africa

Despite the fact that municipalities have a vital role to play in planning and implementing climate change adaptation, numerous barriers are encountered when they do so, especially at the contextual level. A study was the transfer to analyse these barriers and enablers, both via literature review and case study analysis of four South African municipalities. Comparison of barriers and enablers across the four case studies reveal significant and common barriers, such as the lack of governance. Municipalities struggle to implement climate change adaptation and community based adaptation within contexts of significant social, economic and ecological challenges. The contextual level is the most challenging, especially when being faced with significant cognitive barriers, lead to reactive responses. Existing municipal systems and structures make it difficult to enable climate change adaptation, which is inherently cross-sectoral, multidisciplinary and especially community based adaptation that is bottom-up and participatory. Lack of locally applicable knowledge, funding and human resources were found to be significant resource barriers, and were often explained by social barriers relating to perceptions, norms, discourses and governance challenges. Enablers of engagement for officials, operating within enabling organisational conditions and drawing on partnerships and networks, were often unattainable due to perceived barriers. When these enablers coincided with windows of opportunity that increased the prioritisation of climate change within the municipality, projects with ancillary benefits were often implemented.

P-3328-19

Predicting future climate for adaptation in northern Côte d’Ivoire: contribution of statistical downscaling model

K. Yao Etienne (1); K. Brama (2); C. Guéladio (3); S. Issiaka (4); A. Konare (5)
(1) Centre Suisse de Recherches Scientifiques en Côte d’Ivoire, Abidjan, Ivory Coast; (2) Université Félix Houphouët Boigny of Abidjan, Ivory Coast; (3) Université d'Abidjan, Abidjan, Ivory Coast; (5) Université Félix Houphouët Boigny of Abidjan, Ivory Coast

In the region of Korhogo in northern Côte d’Ivoire, recent climate variations are marked by a superposition of droughts and floods. These events contribute to worsening the wellbeing of populations, particularly the most vulnerable. To enhance the actual and future resilience and adaptation capacity of these people, it is necessary to have more information on present climatic parameters and their future evolution.

Temperature and rainfall of the white Bandama basin in the region of Korhogo from 1921 to 2000 were collected at the Société d’Exploitation et de Développement Aéroportuaire, Aéronautique et Météorologie (SODeXAM) and processed. Statistical downscaling method was used to test the hypotheses that the minimum temperature (20.87°C) could increase by 0.48°C, 1.16°C and 2.02°C respectively at the horizons 2020, 2050 and 2080. For current average temperatures (26.8°C), the increase could be 0.44°C, 1.13°C and 1.96°C respectively for the three horizons. When actual maximum temperature (32.27°C) could increase by 0.31°C, 1.36°C and 1.17°C also for the same horizons. According to B2 scenario, minimum temperature could increase by 0.43°C, 0.82°C and 1.39°C for the three horizons. Current average temperatures could increase by 0.43°C, 1.13°C and 1.33°C according to B2 scenario. And for maximum temperature, increase could be 0.78°C, 1.11°C and 1.14°C. The months of September and October record the higher values of maximum temperatures.

For precipitation, A2 and B2 scenarios presented the same average annual increase of 34% at the 2020 horizon with a margin of error between 10% and 9% respectively. By 2050, the annual increase could be varied according to A2 and B2. This increase could be 12% and 28% respectively for A2 and B2 by 2080 with lower margins of error of 4% (A2) and 7% (B2). The months of May and June could see the largest increases (149 mm and 109 mm respectively), which is twice the observed quantities. Such information’s are useful for the planning and implementation of programs and plans for adaptation to reduce the potential risks associated with these climatic variations.
Africa’s ecosystem natural resource requires a longer-term historical perspective on human–landscape–environment interactions than is currently available. A synthetic overview of the palaeoecological records from East Africa will be presented and used to chart the interactions between people and their use of ecosystem resources during the transition into agriculture. The time period will draw on the palaeoecological record of the last 6000 years with a focus on the historical past. Zooming in on the past 500 years, we will present how this has been used to build a foundation to construct informed climatic and socio-economic scenarios for the future. The presentation will focus on unpicking the temporal, spatial and complexity of different scales and agencies of the interaction between ecological systems in Eastern Africa to understand the interactions between people, their environment, wildlife, livelihoods, and provide a better potential future for the sustainable future of Africa’s ecosystem. The presentation will unpick how societies, landscapes, ecosystems and Protected Areas have responded to climate change, so as to better understand how they may respond to future climate change and societal use.

0-3329-02

Landscape Resilience and Vulnerability in eastern Africa: an archaeological prospectus for the future

P. Lane (1)

(1) Archaeology & Ancient History, Uppsala, Sweden

The need to create and sustain resilient societies capable of facing the burgeoning challenges posed by accelerating global climate change has become a dominant mantra of our age. Both sustainability and resilience are inherently temporal concepts, but in planning for the future it is often difficult to identify which practices and systems are likely to enhance resilience and which may make communities and even whole societies more vulnerable to the detrimental effects of climate change. For this reason, examples from the past, and specifically tangible evidence for long-lasting socially and ecologically enabling practices are increasingly used as a source of information for planning the future. This paper utilises examples from local landscapes spanning the last ca. 1000 years, this paper outlines some concrete instances of past strategies aimed at enhancing socio–ecological resilience during periods of extreme climate events and critically assesses whether these can be used as models for the future.

0-3329-03

“Growing water” in Northern Kenya: Resilience of the Gabbra ecology and technology of adverse climate change

B. Hazard (1)

(1) Institut Interdisciplinaire d’anthropologie du contemporain, Institut National des Sciences Humaines et Sociales – CNRS, Paris, France

Northern Kenya is frequently described as one of six areas directly impacted by the global climate change as well as a region having a low resilience to climate change. Yet the temporal and spatial dynamics of northern Kenyan socio–ecological systems have been relatively stable within a longer–term variability during the Holocene period. Despite by the Lower Omo Basin and the Lake Turkana basin, ecological conditions have only changed with the prolonged period of severe drought of the late–18th century and earliest 19th century and therefore started to challenge the adaptive capacities of pastoralist societies. The presentation discusses how severe climate variability and recent socio–ecological change is altering or modifying existing traditional resource governance, adaptation strategies and coping mechanisms in Northern Kenya by focusing on how Disaster Risk Reduction programs implemented to adverse effects of the climate change interact with the Gabbra ecology of the Chalbi desert. For long the local concept of "finn" was used to describe human–landscape interaction and to predict climate events and their relation to ecological conditions and adaptation strategies for addressing "finn" water. Based on a complex predictive model, including memory of past climate events, moon calendar and local indicator of ecological condition, this traditional early warning system has probably collapsed with increasing "aid addiction" and the implementation of technological innovation to "grow water" in the desert. From an ethnographic survey done in 2011, the presentation will explore how the lost of local knowledge regarding climate, land and water resource reshape resilient capacities of socio–ecological system. From this situation of environmental acculturization, we will attempt to develop predictive model of climate and more widely the African Union “Policy framework for pastoralism in Africa” may help to build common responses to future climate change.

0-3329-04

Adopting landscape approach in enhancing resource governance, adaptation and resilience in arid and semi-arid lands of Kenya

Y. Salah (1)

(1) IUCN, People and landscape programme, Nairobi, Kenya

Efficient and balanced utilization of natural resources dispersed in spatial and temporal basis in vast landscapes of arid and semi-arid lands is the main survival strategy for pastoralist communities in Northern Kenya and horn of Africa for generations. Natural resource planning and management in pastoral communities is anchored on traditional resource governance mechanisms in Northern Kenya- one of the cornerstone strategies that allows balanced use of the resource and survive harsh climatic conditions and stresses including drought. The traditional institutions plan and manage their resources in a participatory manner at landscape level. External factors including formal government institutions and approaches have weakened these institutions and disrupted sustainable resource management hence making pastoral communities vulnerable to climate change.

Reviving and strengthening the landscape level approaches in resource management and governance that involve all the relevant stakeholders in participatory manner is paramount in facilitating resilience building and adaptation in pastoral areas of Northern Kenya and horn of Africa. Towards entrenching and enhancing landscape level resource management and governance IUCN in collaboration with diverse stakeholders initiated natural resource governance project in northern Kenya- one of the outcomes of the initiatives, opportunities and challenges that exist in adopting landscape level natural resource management interventions under the devolved system of governance in Kenya to enhance resilience and adaptation to climate change.

Integrated natural resource management is anchored on participatory planning and management having high potential in overcoming drought and climate extremes in pastoral areas of northern Kenya. One of the key approaches implemented to facilitate integration is adapting sub-catchment management planning. The approach is based on integration of the rangeland management and sub-catchment management plans to best serve the need of the pastoral communities. Landscape level planning and management was enhanced through this approach by bridging the gap between the formal and traditional resource management systems that derive legitimacy from the national policies and local level governance institutions. The hybrid institution tasked with multiple resource planning and management operations were strengthened through formulation of integrated natural resource management bylaws anchored on traditional systems of resource planning and management which is formalized by county government through the devolved functions hence creating ownership and local control over resources. The bylaws formulation and participatory resource mapping exercise which jointly facilitates tenure rights for resources at landscape level. The devolution process also offers inter–county collaboration on resource use and coordination which is critical as aspect in implementation of landscape level interventions.

The key challenges in effective implementation of landscape level interventions in the northern Kenya are mainly related to low understanding of the value of the landscape approach in resources management which is for pastoral livelihood among some government official. Although there are some challenges there are policies and laws that promote landscape approach at national level and opportunity exists for formulation of the further policies and laws at the county level.

590
The Rusizi plain, an area prone to the challenges of climate change and subject to political contrasts

A. Cazenave-Piarrot (1); C. Thibon (2); G. Joseph (3); G. Rwanyiziri (4); S. Ndayirukiye (5)

(1) Université de Pau et des pays de l’Adour, Géographie, Pau, France; (2) Université de Pau et des pays de l’Adour, Histoire, Université Nice Sophia Antipolis, TERRA, Nice, France; (3) Kigali Institute of Education, Histoire, Kigali, Rwanda; (4) National University of Rwanda, Sciences-géographie, Butare, Rwanda; (5) UNIVERSITÉ DU BURUNDI, GÉOGRAPHIE, BUJUMBURA, France

Statement of the problem: Is it possible to have a political ecology in a natural and human environment which is both subject to the global change and geopolitical tensions?

1. The starting point: The alarm was raised by the increase of natural physical challenges: frequent floods, erosion, fragile biodiversity, soil degradation, epidemics, etc. which reveal a serious ecological crisis which, nonetheless, is not the first one in the region.

- This crisis goes back into the past from the demographic pressure on the environment and its resources. It takes various aspects: settlement front in the plain, rapid urbanization, overpopulation, degradation of watersheds which undermine, beyond hill level, the upper slopes and the forests.

- This gap has been maintained by political instability over the last 30 years of civil wars accompanied by forced migrations, depopulation of one area and resettlement in another, the intensification of land disputes between herdsmen and farmers, which have been exacerbated by contrasting political styles of governance in different countries and, even more, by the effects of climate change (rainfalls, intensity of natural disasters—this needs to be better identified).

2. Short and mid-term projections: in the mid-term, the projections confirm this pattern and even exaggerate it: the Rusizi plain is a breathing space for poor populations, due to a conservation policy and development and agriculture projects. It is becoming an attractive economic frontier due to emerging economies, asymmetric national economies and their new sources of revenue (trade, tourism, etc.), an area for farming activities (rice—growing and processing project and cattle farms, etc.), an area with high demographic growth, both natural and due to migrations (refugee resettlement, long-term settlement in camps).

- Demographic policies, initiated in the three countries, although in an unequal manner, have had little or no effect in the mid-term, due to the inertia of the population movement.

- In addition to the above, you also have political, geopolitical, sub regional and bilateral challenges amid instability in some sub-regions of the Rusizi, conflicts between asymmetric political systems (strong/weak/failed state: Rwandan, Burundian and Congolese), fueled by outbreaks of rebellion in connection with the politics in the three countries, and to which could be added territorial disputes. This situation does not help nascent public policies.

3. The way forward: In response to these challenges, sectoral approaches as well as technical—economic processes are possible, but they lack a comprehensive political framework. The best known are conservation policies for threatened areas (niches, protected areas, parks and nature reserves), with local/zonal public policies, with technical solutions for each type of soil (land use plan and landscape map). The aim is a sustainable agricultural and agro pastoral development, with a view to improving the population’s living conditions. These require comprehensive policies that would lead to a land conflict planning (diagram), with harmonized sectoral policies and investments (water, energy, town, mines agriculture, tourism).

- Everything will depend on the role of the states, the international and regional community, the provincial and municipal authorities and their cross-border cooperation, the national and international civil society, the means invested in such a scheme, focusing on the public good across the borders and in the region, with a view of creating ‘peace lands’; hence, the relevance of a political ecology.
P-3329-01
Geothermal Development in Kenya, a Climate Resilient strategy?

C. Adongo (1); B. Hazard (2)
(1) EHESS, Anthropology, Paris, France; (2) Institut Interdisciplinaire d’anthropologie du contemporain, Institut National des Sciences Humaines et Sociales – CNRS, Paris, France

Due to high vulnerability and lower adaptive capacity, Africa is predicted to contend with greater impacts resulting from climate change. This could potentially hamper past and future developments. 83% of Kenya, for example, consists of Arid and Semi Arid land inhabited by populations which are highly vulnerable. Moreover, there is indication that ASALs are increasing, one consequence of deforestation and climate change. According to the Stockholm Environment Institute (2009), major droughts occurring in 1998–2000, 2004/2005 and 2009 resulted in economic losses worth approximately $2.8 billion from water and energy deprivation. Declined water levels in dams for hydroelectric power production also caused widespread electric power rationing. In accordance with the Kyoto protocol, calling for countries to commit to decreasing greenhouse gases, and the World Summit on sustainable Development (WSSD) specifically requiring countries to commit to producing 10% of their energy from renewable sources, the National Climate Change Response strategy of 2010 asserts that following a low carbon development path will result in significant economic and huge environmental and social benefits. The focus is to zero real activity on catchment soil erosion through time. The three

P-3329-02
Nubians as Egyptian Indigenous people and Climate Change Mitigation

EHM. Ahmed (1)
(1) Lead Author, WG III, IPCC, climate change and sustainable development, Cairo, Egypt

Egypt and Sudan are the most populous countries in Africa and the Middle East. Nile River is considered as a very important artery that joins Sudan and Egypt. Nile was an important part of ancient Egyptian spiritual life. Nubian peoples are an ethnic group; they considered as one of the most ancient peoples all over the world. Their civilization started more than 8,000 years ago. Lake Nasser is the second largest man–made lake in the world; among the impacts that were anticipated were the resettlement of irrigation in the area induced by the reservoir, saving of historical monuments, health impacts and coastal erosion.

The climate models all estimate a steady increase in temperatures for Egypt, with little intermeddle variance. Somewhat more warming is estimated for summer than for winter.

However, since Egypt is mainly a desert and relies primarily on irrigated agriculture, precipitation over the country itself matters very little. Much more important are precipitation changes at the water sources of the Nile, which affect the vulnerability of water resources.

The potential impacts of climate change on coastal resources are ranked as most serious. Climate change induced sea level rise only reinforces this trend. In addition to this high biophysical exposure to the risk of sea level rise, Egypt’s social sensitivity to sea level rise is particularly high.

In general, although the models on average show an increase in precipitation, inter-model variation is so high that it is uncertain as to predict whether annual average precipitation will increase or decrease.

P-3329-03
A meta-analysis of long-term land management effect on Soil Organic Carbon (SOC) in Ethiopia

AS. Dakka (1)
(1) University of Bern (UB) and USAID/Ethiopia, Science faculty (ub) asset and livelihood in transition office (usaid), Addis Ababa, Ethiopia

The role of Soil Organic Carbon (SOC) in mitigating climate change, indicating soil quality and ecosystem function has created research interested to know the nature of SOC at landscape level. The objective of this study was to examine variation and distribution of SOC in a long-term land management at a watershed and plot level.

This study was based on meta-analysis of three case studies and 128 surface SOC data from Ethiopia. Three sites (Gununo, Anjeni and Maybar) were compared after considering two land management categories (LMC) and three types of land uses (LUT) in quasi–experiment design. Shapiro–Wilk tests showed non–normal distribution (p=0.002, α=0.05) of the data. SOC median value showed the effect of long–term land management with values of 2.29 and 2.38 (g/kg) for less and better–managed watersheds respectively. SOC values were 1.7, 2.8 and 2.6 (g/kg) for Crop (CLU), Grass (GLU) and Forest Land Use (FLU) respectively. The rank order for SOC variability was FLU>CLU>CLM. Mann–Whitney U and Kruskal–Wallis test showed a significant difference in the medians and distribution of SOC among the LUT, between soil profiles (p<0.05, confidence interval 95%, α=0.05) while it is not significant (p>0.05) for LMC. The mean and sum rank test showed a significant difference in the medians and distribution of SOC among the LUT, between soil profiles (p<0.05, confidence interval 95%, α=0.05) while it is not significant (p>0.05) for LMC. The mean and sum rank test showed a significant difference in the medians and distribution of SOC among the LUT, between soil profiles (p<0.05, confidence interval 95%, α=0.05) while it is not significant (p>0.05) for LMC.

P-3329-04
Reconstructing 200 years of human-induced soil erosion in the Lake Baringo catchment (Kenya) based on sedimentology and geochemistry of lake sediments

A. Degefa (1); I. Bessemens (1); R. Tjallingii (2); B. Cumming (3); D. Verschuren (1)
(1) Ghent University, Biology, Limnology Unit, Gent, Belgium; (2) German Research Centre for Geosciences (GFZ), Climate dynamics and landscape evolution, Potsdam, Germany; (3) Queen’s University, Biology, Ontario, Canada

Summary. Land degradation due to loss of vegetation and fertile soils by strong erosion during the rainy season is one of the major environmental problems affecting the Lake Baringo catchment in Kenya’s central Rift Valley. In this study we used magnetic susceptibility and X-ray fluorescence (XRF), and grain–size measurements on sediment cores from Lake Baringo to trace the variable influence of human activity on catchment soil erosion through time. The three studied sediment sequences, recovered from different offshoare locations, display a similar stratigraphy of fine–grained and low–organic lacustrine clays deposited above stiff clays representing a desiccation horizon dated to the late 18th – early 19th century.
High-resolution magnetic susceptibility and XRF data reveal a cyclic pattern of peak values with apparently annual periodicity, particularly in sediments dated to the early to mid-20th century. It is interpreted as alternating seasonal spits of sediment influx from rivers and direct run-off, linked to increased population and livestock pressure. Results of grain-size analysis indicate that the very fine-grained clay sediments dominating this particular zone are derived from old lacustrine sediments, originally deposited in offshore deposits of the early Holocene ‘mega-lake’ Baringo, but which is now part of the gently-sloping Rift Valley plains surrounding the lake today. Sediment thickness above the desiccation horizon increases towards the southern end of the lake, due to high sediment influx from the Perikera and Molo Rivers, which drain the largest catchment area. Lead-210 dating of these 200-year sequences shows that variation in the rate of sediment accumulation is strongly influenced by historical lake-sequences shows that variation in the rate of sediment accumulation is strongly influenced by historical lake-level fluctuations, with accumulation maxima occurring during lowstands due to sediment being concentrated into smaller area of accumulation.

P-3329-05
Understanding the Vulnerability to Climate Change Effects in East Africa. Case Study of Rice Farmers in Bugesera District, Rwanda
G. Rwanyiziri (1)
(1) University of Rwanda, Centre for geographical information systems and remote sensing (cgis), Huye, Rwanda

Located in the Eastern region of Africa, Rwanda has been faced with unusual irregularities in climate patterns including extreme temperatures, variability in rainfall frequencies and intensity over the last 30 years. In fact, the analysis of rainfall shows that, since 1992, Rwanda has been characterized by a declining trend with a remarkable variability in rainfall frequencies and intensity which resulted into serious floods in 1997–1998 and a prolonged drought in 1999–2000. This study has been conducted in Bugesera District to reveal the effects of climate change on rice farmers. According to the results, the rise in temperature and changes in the amount of rainfall and its distribution have altered the availability of water resources, consequently affecting the productivity of rice. The variability in the onset of the rainy season has led to variation in the start of the planting season which has negatively affected the production of rice. Assessment of people’s perceptions on ongoing change on rainfall and temperature patterns, and their adaptation strategies has been made. The respondents accept that there is a change happening in their area and have already started to feel its impacts. The study revealed that yields of rice have been distorted by changes in precipitation, temperature, as well as soil moisture. Flooding in lower zones of altitude along river Akanyaru have been reported for many times in the study area as causing the submergence of rice fields thereby damaging the growth and reducing the productivity of rice. In adaptation to climatic change effects, rice farmers have started to take on some adaptation measures. These measures include constructing small water retention reservoirs to collect water for irrigation use in the dry season, switching to new varieties of rice that resist to drought and flooding, and application of pesticides to combat with pests.

3330a - Facing climate change in Sub-Saharan Africa

K-3330a-01
Observatories, a Key Tool to Tackle Climate Changes in Tropical Regions
T. Lebel (1); C. Peugeot (2); M. Grippa (3); S. Galle (1)
(1) IRD, LTHE, 38041 Grenoble Cedex, France; (2) IRD, Hydrosciences montpellier (hsm), Montpellier, France; (3) Université de Toulouse, Get, Toulouse, France

This will be illustrated through the history and achievements of the AMMA-CATCH and other observing systems (IDAF, PHOTONS, Dust-Transsect, GPS) providing the ground to debate the need for consolidating a collaborative strategy for tropical climate change observations and to discuss how to reinforce the science/policy interfaces in this area.

K-3330a-02
Climate Change Projections in the Sahel. The what and the why
M. Biasutti (1)
(1) Columbia University, Lamont Doherty Earth Observatory, Palisades, NY, United States of America

This talk will review the projected 21st century changes in temperature and precipitation at seasonal and sub-seasonal scale in Subsaharan Africa, with particular emphasis on the Sahel and the West African Monsoon region.

Greenhouse-gas induced temperature increases are large compared to interannual variability and such forced seasonal temperature anomalies are decoupled from the occurrence of drought or pluvials; this results in a robust projection of unprecedented seasonal temperatures by mid-century.

Precipitation anomalies remain more uncertain. In the Sahel, although outlier models remain, the ensemble anomalies indicate lesser precipitation totals in the west and greater in the east, a characteristic that is also reflected in model projections of temperature and evaporation. Drought anomalies typically manifest in a delay in the beginning, peak, or demise of the rainy season.

Additionally, we present the projected changes in the characteristics of rainfall and in the occurrence of extreme events and we evaluate the robustness of such anomalies with respect to model uncertainty, natural variability, and the use of statistical downscaling to debias daily rainfall and temperature.

Finally, we interpret seasonal rainfall anomalies in terms of thermodynamic and dynamic forcings and in terms of regional and global modes of change. We emphasize the role of the large-scale circulation and the forcing from both the tropical and the midlatitude sea surface temperature anomalies.

International Scientific Conference     7-10 JULY 2015    PARIS, FRANCE
External forcing and Sahelian African climate anomalies - A study from the WAMME project

Y. Xue (1) ; W. Lau, (2) ; A. Boone, (3) ; Sl. Seidou (4) ; W. Thiai (5) ; L. Druyan, (6) ; D. Rowell (7)

(1) Professor, UCLA, Dept. of geography & dept. of atmospheric and oceanic sciences, Los Angeles, United States of America; (2) Goddard Institute for Space Studies/Columbia University, New York City, United States of America; (3) Met Office Hadley Centre, Exeter, United Kingdom

The Sub-Saharan Africa is a diverse climatic and economically fragile region and dramatic change over the last 100 years has brought much drier conditions in the 1970s-1980s and then to partial recovery from the 1990s represents one of the strongest interdecadal climate variability and the longest drought on the planet in the twentieth century. A significant climate feature in the Sahelian Africa is the West African monsoon (WAM), which variability dominates the climate variability there. However, the CMIP5 coupled models underestimate the WAM decadal variability and the drought. Although encouraging progresses have been achieved, many systematic and robust biases of the coupled and atmospheric models have not improved from CMIP3 to CMIP5. It is therefore essential to have comprehensive understanding on the past Sub-Saharan decadal variability and predictability to provide reliable assessment of future climate change and adequate strategy for mitigation and adaptation under changing climate.

In past several decades, the West African climate community has recognized the importance of external forcings: changes in the land cover, and land use change (LULCC), aerosols, and greenhouse gases, on WAM variability, especially their roles in the Sahel drought. However, most of these studies only focused on one external forcing with one single model. The West African Monsoon Modeling and Evaluation (WAMME) is a project comprised of both general circulation models (GCMs) and regional climate models (RCMs) with the objective to collectively provide best estimation of the relative importance of all those external forcing on WAM at seasonal to multi-decadal time scales. WAMME research activities are closely coordinated with those of AMMA, involving many African institutions. The observational and other relevant datasets acquired from AMMA provide important benchmark for assessing the role of external forcing in regional climate variability and anomalies.

In this paper, we mainly present the latest results from the WAMME-2, which is designed to test how seasonal and decadal climate variability of WAM precipitation is associated with external forcings, and assess their relative contributions in producing/amplifying the WAM seasonal and decadal climate variability. The sensitivity of the WAM variability to those external forcings is also examined. The WAMME-2 strategy is to apply observational data-based anomaly forcing of SST, land surface and aerosols, i.e., "idealized but realistic" forcing, in GCM and RCM simulations against the specific/ideal forcing to evaluate the relative impacts of each forcing and feedback mechanisms.

In the SST experiment, in addition to the global SST effect, each ocean is also individually evaluated. The results from most GCMs consistently indicate that SST has a maximum impact on the WAM decadal variability compared with other forcings, and that the effect of the Pacific Ocean is larger compared to the models, and differ in producing other oceans' contribution. Moreover, the models with specified maximum SST anomaly forcing are still unable to produce full Sahel drought (only slightly above 50% of full Sahel drought) or the LULCC experiment. A newly available land use change map is applied. A consistent change in the vegetation maps is imposed for each model group. The simulated LULCC impact is also still unable to produce more than about 30% of the SST forcing (about 40% of the drought). In the dust experiment, the direct impact of dust on the radiation budget and its influence to the Sahel rainfall are evaluated using the GOCART dust data and its effect also contributes to the drought (less than 20% of the drought). In addition, some preliminary results for impact of the greenhouse and global warming on the West-Sahara climate decadal variability will also be presented.

WAMME is the first attempt to use multi-GCMs and RCMs to collectively explore the roles of multiple external forcing in WAM variability. WAMME2’s achievement provide better understanding of relative importance of various forcing and possible feedback mechanisms, complementary to experiments under CMIP5, which is focus on impacts of emission scenarios, and CORDEX, which is focus on RCM downscaling ability. The results from WAMME should provide useful information to analyze and understand the CMIP results for future climate change and help design impacts scenarios and plan adaptation options.

Projected Climate Conditions over West Africa for the End of the 21st Century: Impact on Extreme Precipitation Events

MB. Sylia (1) ; D. Wissel (2) ; N. Elguindi (3) ; F. Giorgi (3)

(1) WASCAL Competence Center, Climate Modeling and Change, Ouagadougou, Burkina Faso; (2) University of Bonn, Center for development research (zei), Bonn, Germany; (3) Abdus Salam International Centre for Theoretical Physics (ICTP), Earth system physics (esp) section, Trieste, Italy

Global warming resulting from increased anthropogenic greenhouse gas (GHG) forcing (RCP8.5) will lead to significant changes in West African regional climate conditions. 21st century projections from both Global Climate Models (GCMs) and Regional Climate Models (RCMs) indicate lower warming along the Gulf of Guinea and higher over land areas in West Africa. Furthermore, increases in extremes are more vulnerable to the seasonal timing of the occurrence of extremes than its yearly average. Estimating and understanding such seasonal and sub-seasonal changes is important for the formulation of adaptation and mitigation strategies as the seasonal rainfall events is concurrent to the peak of the rainy season, this may result in widespread flooding requiring strong responses. As another example, in the case of precipitation high intensity rainfall events, early deployment of flood control measures may be required.

In this context, recent studies identified also substantial increases of very high monthly precipitation and an amplification of daily precipitation extremes by the end of 21st century. These increases are considerably spatially variable over West Africa and mostly driven by an intensification of the local hydrological cycle. However, key sectors and activities in West Africa may be more vulnerable to the seasonal timing of the occurrence of extremes than its yearly average. Estimating and understanding such seasonal and sub-seasonal changes is important for the formulation of adaptation and mitigation strategies. For example, in the case of precipitation high intensity rainfall events, early deployment of flood control measures may be required.

In this study, the revised Thornthwait climate classification is employed to investigate the shift of West African climatic zones in response to future anthropogenic climate change under two Representative Concentration Pathways (RCP4.5 and RCP8.5) from multiple data sources: ensemble means of GCMs and RCMs, and possible feedback mechanisms, complementary to experiments under CMIP5, which is focus on impacts of emission scenarios, and CORDEX, which is focus on RCM downscaling ability. The results from WAMME should provide useful information to analyze and understand the CMIP results for future climate change and help design impacts scenarios and plan adaptation options.
and post-monsoon (October–December) seasons. This task is carried out through the analysis of a series of standard indices of precipitation extremes applied to the daily precipitation projections. The results reveal that West Africa evolves towards increasingly arid and semi-arid regimes with the recession of moist and wet zones, thus adding another element of vulnerability to future anthropogenic climate change for the ecosystems and agricultural lands in the regions.

In addition, analysis of the changes in the annual of high intensity precipitation events indicate that the pre-monsoon season experiences the largest changes in daily precipitation statistics. These changes are particularly towards an increased risk of drought associated to a decrease in mean precipitation and frequency of wet days, and increased risk of flood associated with very wet events. Both these features can produce significant stresses on important sectors such as agriculture and water resources at a time of the year (e.g. the monsoon onset period) where such stresses can have stronger impacts.

O-3330a-02
Trends in West African floods: A comparative analysis with physiographic indices

NN. Bernadette (1) ; H. Karambiri (2) ; O. Ludovic (3) ; P. Ribstein (4) ; J. E. Paturol (5)
(1) International Institute of Water and Environment Engineering, Ouagadougou, Burkina Faso; (2) 2IE, Ouagadougou, Burkina Faso; (3) UPMC, Metis, Paris, France; (4) Université Pierre et Marie Curie, Laboratoire sisyphe, Paris, France; (5) IRD, HydroSciences Montpellier, Abdijan, Ivory Coast

After the drought of the years 1970 in West Africa, the variability of rainfall and land use changes affected mostly flow, and recently, flooding is said to be an increasingly common occurrence throughout the whole of West Africa. These changes aroused many questions about the impact of climate change on the flood regimes in west african countries.

This paper investigates whether floods are becoming more frequent or more severe, and to what extend climate patterns have been responsible of these changes. We analyze the trends in floods of 14 catchments within the main climate zone of West Africa. The methodology includes two types of sampling flood events, namely the AM (Annual maximum) method and the POT (Peak over threshold), and two perspectives of analysis are presented, precisely long term analysis based on two long time series of flood, and regional perspective involving 14 catchments with shorter length of series.

Mann Kendall trend test and Pettitt break test are used to assess the stationarity of the time series. The trends detected in flood time series are compared to the trends of rainfall indices in one hand and vegetation indices in the second hand using contingency tables, in order to identify the main driver of change in flood magnitude and flood frequency. The dependency between flood index and physiographic index is estimated through a Success Criterion and the CramerV criterion calculated from the contingency tables.

The results point out the existence of trends in flood magnitude and flood frequency time series with two main patterns. sahelian flood show increasing trends, and some sudanian catchments present decreasing trends. for the overall studied catchments, the maximum five consecutive days rainfall index (Rx5d) seems to follow the trend of floods, while NDVI indices do not show significant link between with the trends of floods, meaning that this index has no impact in the behaviour of flood in the region.

O-3330a-03
Evolution of surface temperature and heat waves over West Africa during the near and the far future

M. Camara (1) ; AB. Sarr (2) ; I. Diba (3) ; A. Diedhiou (4)
(1) Laboratoire d’océanographie, des sciences de l’environnement et du climat (LOSEC), Université de Ziguinchor, Ziguinchor, Senegal; (2) Laboratoire d’océanographie, des sciences de l’environnement et du climat (LOSEC), Université assane seck de ziguinchor, Ziguinchor, Senegal; (3) Laboratoire d’océanographie, des sciences de l’environnement et du climat (LOSEC), Université assane seck de ziguinchor, Ziguinchor, Senegal; (4) Institute of Research for Development (IRD), LTHE – University Grenoble Alpes, Grenoble Cedex 9, France

The aim of this work is to study the spatio-temporal variability of the future evolution of surface temperature and heat waves over West Africa using regional climate models outputting engaged in Coordinated Regional Downscaling Experiment (CORDEX) project. CORDEX is an international project implemented by many research centers worldwide which aims to supply reliable climate change scenarios to the scientific community. These simulations are perfomed with the latest state of the art regional climate models over most emerged lands of the planet for environmental impact studies and also to characterize the associated uncertainties. The data analyzed within the framework of this work are the climate change projections performed with the latest greenhouse gaz emission scenarios: RCP4.5 and RCP8.5.

This work focuses on the near (2020–2050) and the far (2070–2100) future and analyzes the spatio-temporal variability of the surface temperature and heat waves episodes over West Africa; these heat waves remain under studied over this region despite their negative impacts on the populations and their socio–economic activities.

3330b - Facing climate change in Sub-Saharan Africa

ORAL PRESENTATIONS

K-3330b-01
Assessing climate impacts and adaptation options for cereal systems in West Africa

D. Lobell (1) ; K. Guan (1) ; M. Biascutti (2) ; C. Baron (3) ; S. Benjamin (4)
(1) Stanford University, Department of environmental earth system science, Stanford, United States of America; (2) Columbia University, Lamont–doherty earth observatory, New York, United States of America; (3) CIRAD, Montpellier, France; (4) 40 rue Joseph Gaillard, Vincennes, France

Much has been learned in recent years about the nature of climate changes in the West African region, including robust regional monsoon onset delay and, in many locations, increased late-season rainfall. This talk will examine the implications of these changes for crop adaptation strategies. Two process-based crop models (APSIM and SARRAH-H) are used to explore climate change impacts under various management and cultivar scenarios for sorghum, the main crop in the region. Potential adaptation strategies we test include more conservative sowing rules (to reduce risks of early-season drought stress and crop failure), a switch to longer–season varieties (to avoid shortening of the growing period), increased fertilizer rates and planting density (to take advantage of increased late–season rainfall), switching from photo–sensitive to photo-insensitive varieties, and rainwater harvesting to provide supplemental irrigation. The results are analyzed in terms of effects on both average and variability of yields, with the goal being to identify strategies that will very likely reduce negative impacts of climate trends on average and/or variability of yields, while not sacrificing performance in the current climate. Such strategies could then be promoted as adaptation priorities in the region.

K-3330b-02
The challenge of water resource management in the Lake Victoria basin, East Africa

H. Houghton-Carr (1) ; M. Fry (2)
(1) Centre for Ecology & Hydrology (CEH), Wallingford, United Kingdom; (2) Centre for Ecology & Hydrology (CEH), Water information management, Wallingford, United Kingdom
The Lake Victoria basin, in the headwaters of the Nile in East Africa, is home to over 30M people. As the population continues to increase, demands for water for irrigation, hydropower, and domestic and industrial supply are growing rapidly. The significant drop in Lake Victoria water levels began in 2000 and reaching the lowest level since the 1940s six years later. Inconvenienced those who depend on the lake for their livelihoods and generated not just a regional, but a global, debate. A number of initiatives targeting the cause of the decline were advanced by the scientific community, the regional press and the citizens of the five riparian countries, namely Burundi, Kenya, Rwanda, Tanzania and Uganda.

Lake levels are a primarily a function of regional climate and resultant lake rainfall and evaporation; the impact of water releases for hydropower and other abstractions within the basin remains still between 30 and 50% of the Lake Victoria region is characterised by high intra- and inter-annual climatic variability, the consequence of which is significant uncertainty in future rainfall on, and inflows to, the lake. Hydrological timeliness of natural and artificial water resources have always been considered important for the assessment and management of water resources. However, many countries in sub-Saharan Africa, and elsewhere, have experienced a marked decline in hydrometeorological data collection and management in recent years.

An increasing need is emerging for long-term datasets to understand how national and basin-scale hydrological regimes are responding to climatic variations and anthropogenic influences. Predicting future water availability, effective water resource planning under climate change and population growth, requires well-founded predictions of regional climate, hydrology and societal demands across the basin. Whilst climate and hydrological models can inform about expected impacts of change, validation of these models requires real data. In an interesting paradox which illustrates the current lack of capacity to predict the impacts of climate variability and changes on water resources, the East African long rains are observed to be decreasing, whilst climate models predict an increase.

Initiatives to improve understanding of the climate and hydrology of the lake basin are welcomed e.g. GEWEX HyVic regional hydroclimate project, DFID–NERC FCFP (Future Climate for Africa) programme, and WMO data rescue activities, which aim to identify and preserve records that capture natural variability.

K-3330b-03

Using climate information to build resilience agriculture for farmers in Kaffrine district in Senegal

O. Ndiaye (1) ; M. Seck, (2) ; D. Ndiaye, (1) ; R. Zougmore (3) ; M. Ndiaye (1) ; M. Seck, (2)

(1) ANACIM, research and development, dakar, Senegal; (2) DDR, Agriculture, Kaffrine, Senegal; (3) CCaFS, Bamako, Mali

Senegal, at the image of many Sahelian countries, is one of the most affected area by climate variability. Climate is varying at decadal, inter-annual and sub-seasonal time scales. So population living in such environment are affected by climate shocks in their livelihood.

Funded by the CCaFS initiative there is a 5 years going on project with farmers demonstrating how to use climate information to help farmers in their decision making. This initiative is a multi-disciplinary and multi-scale processes. We worked with local government representative who calls and leads such meeting. Now the project is at its upscaling phase to other districts of Senegal using rural radio network. In the upscaling process radio communiti journalists are trained to understand climate information in order to disseminate such information at broader scale.

We will present lesson learnt and evidence in this project during these 5 years for a smart agriculture.

O-3330b-01

Yield Gap and the shares of climate and crop management in yield variability of staple crops in West Africa

F. Affholder (1) ; B. Sultan (2) ; P. Kouakou (3) ; C. Poeydebat (4) ; M. Muller (5)

(1) CIRAD, UR AIDA, Montpellier, France; (2) IRD, Paris, France; (3) CIRAD, Bobo-Dioulasso, Burkina Faso; (4) CIRAD, Martinique, le Lamentin, France; (5) CIRAD, BIOS, Montpellier, France

« Yield gap » (Yg) is a key concept of agricultural science for identifying the room for improvement of yields through better management of the agroecosystem. In rainfed agriculture Yg is the difference between the observed yield and the theoretical water limited yield (Yw) that would be achieved if solar radiation, temperature and precipitations were the only factor limiting the crop’s growth and yield. Changes in Yw over regions and years are due to climate–soil interactions that are not easily modified by crop management, whereas changes in Yg are due to limiting factors that are typically within the scope of crop management such as nutrient availability, weeds, and pests.

We provide an example of yield gap estimates in semi-arid Africa, using yield and other agronomic data collected in farmers’ fields of Senegal in 1990 and 1991 and from 2006 to 2012. It illustrates how contrarily to what most people would expect climate is not, on average, what most limits yields in that region: a key lesson is to manage a quarter of water limited yield, and this is due to constraints whose reduction is technically possible albeit subject to the economic and environmental relevance of doing so.

Most studies dealing with the impact of climate change on agriculture in West Africa compare Yw under present and future climate as predicted by climate models. The magnitude of those predicted long term changes in Yw by 2050 is down to -20% in the worst scenario combining a +6°C change with a +20% rainfall change. Such changes in water limited yields are certainly concerning, but they are remarkably small compared to the potential +390% increase that would result from closing the current yield gap.

When considering yield variations observed across plots and years, and not anymore regional averages over a few years, what strikes is the stability of observed yields compared to crop potential yield. We used crop model simulations with historical series of 20 years of weather data to compare yield distributions over years of a crop grown using 3 contrasted levels of fertilisation and no incidence of weeds, pests or diseases. For each fertilisation level, the simulated yield reached a maximum value the ‘best year’ of the series. The three fertilisation levels were chosen so that the maximum simulated yield reached 0.25 Yw, 0.5 Yw, and 0.75 Yw respectively. the maximum simulated yield reached a maximum value the ‘best year’ of the series. The three fertilisation levels were chosen so that the maximum simulated yield reached 0.25 Yw, 0.5 Yw, and 0.75 Yw respectively. The resulting simulated yield distributions show that even if management allows increasing the median yield, in many years the climate is the main limiting factor and fertilising has no or a slight impact only. in other words, the way the current climate limits crop production in this region is by making uncertain the output of investing for high yields. Buying fertilizers or working hard for manure collection, transport and distribution do not translate, a certain number of years, into more production. For farmers struggling for the daily subsistence of their family,
that kind of risk may not be justified while alternative use of family resources in land and labor force lead risky ways to produce subsistence means. Until recently, in many farming systems of West Africa, the growth in food needs due to population growth in rural areas was matched by increases in crop yields or livestock on land (i.e. extension rather than intensification of crop or livestock activities). When rural families reached the limits of this strategy, migrations of many kinds of distance and duration became the adjustment variable to the gap between resources available from farming and population needs. This suggests that for many, it is less risky to be late rather than to intensify cropping or livestock systems. Anyway, as job opportunities for migrants from the rural zones are currently low in West African cities and elsewhere, there are legitimate concerns about the way this strategy may soon reach its limit as well.

In terms of climate change, the worst scenario for farmers of that region would be if crop intensification became even more risky under future climate than at present. There is thus an urgent need for joint agronomic and climate research to go beyond the prediction of Yw or of yield under unchanged crop management and determine whether or not the future climate will increase the yield risks associated with crop intensification in that region. But this should not divert from designing and implementing policies incentive to such intensification under present climate, as this might be much easier now than later.

**The re-greening Sahel: How green is green enough?**

C. Darcel (1); L. Kerгоt (2); P. Hiernaux (2); M. Grippa (3);
E. Mougin (2)

(1) LSCE/CESBIO, Toulouse, France; (2) GET, Umr cnrs 5563,
Toulouse, France; (3) Université de Toulouse, Get, Toulouse,
France.

The Sahel region has long been the focus of a debate on its possible desertification, especially because of its sensitivity to climatic variations. This debate was fuelled following the extreme droughts that occurred and peaked in the mid 1970s and mid 1980s. Since the appearance of global and frequent satellite observations, a re-greening theory emerged in the 1990s, in total contradiction with a desertifying Sahel. This re-greening is simply defined as an increase in a vegetation index such as the Normalized Difference Vegetation Index (NDVI) which is widely used by the community as a proxy for above-ground Net Primary Production (ANPP).

The AVHRR instruments onboard the NOAA satellites provide daily NDVI data since 1981 at the global scale, and thus have been widely used for monitoring vegetation productivity variations. Detrending temporal trends over the Sahel since the 1980s clearly evidence the re-greening of the Sahelian belt. However, such data are subject to uncertainties, so that there is a real need for independent validation of this re-greening observed from space. However, this validation is very difficult to make since field measurements of vegetatio mass are scarce at a matching scale, especially in the Sahel, and especially over long time periods.

In the framework of an ILRI–ILCA project and afterwards thanks to the AMMA–CATCH observatory, we benefited from a large number of much more complex database collected over the pastoral Gourma region in Mali (1984–2011) and over the agro–pastoral Fakara region in western Niger (1994–2011). These databases provide, among others, variations of ground herbaceous biomass giving at the end of the growing season as a proxy for ANPP. Data are available over a large number of sites covering the landscape heterogeneity.

The objective of this study was to evaluate the performance of NDVI products (especially the new GIMMS3g dataset) as compared with long-term field observations. Our analysis over the Gourma region showed that the satellite detected a strong re-greening over the 1984–2011 period, whereas a negative trend was found over the Fakara region in Niger. Moreover, we were able to show contrasted changes depending on the different soil types found in the Gourma: whereas the deep sandy soils show a clear recovery from the droughts, the trend is heterogeneous over the shallow soils with some sites showing a recovery and others not. The picture is also variable over the clayed soils usually located in small depressions. The negative trend found over the Fakara region could be attributed to changes in land use, since this region has experienced a large increase in agriculture since the 1950s. However, the landscape being fragmented and very dynamic, further studies have to be done to fully understand the changes observed in the vegetation cover.

In both cases, a very good agreement is found between re-greening changes derived from ground and field observations, giving additional confidence to the satellite archive. The Sahelian re-greening observed over the past three decades therefore seems undisputable. However, this re-greening does not happen everywhere, and contrasted changes may have happened at a finer spatial scale, thus demanding caution in concluding about the resilience of the ecosystems. In any case, since the re-greening is mostly explained by a recovered rainfall over the past decades, the future climatic conditions and especially the rainfall trend will have a tremendous impact on the evolution of the vegetation cover in the semi-arid Sahel. Of particular concern is the fate of areas already showing an absence of greening (eroded shallow soils, Fakara area for instance).

**The probable impacts of climate change on malaria and Rift Valley fever in Africa**

A. Morse (1); C. Caminade (1); A. Jones, (1); J. Leedale, (1);
A. Tompkins, (2)

(1) University of Liverpool, Geography and Planning,
Liverpool, United Kingdom; (2) ICTP, Trieste, Italy.

Dynamical models of disease transmission between vectors and hosts are back to the vectorial capacity of diseases including malaria and more recently Rift Valley fever. These models are driven by climatic and other environmental variables. This is a complex task, as the models require both accurate projections of the seasonally varying mean values of the climatic drivers and their correct variability across a range of time scales from days to multi–decades.

The relationship between finding parameter settings that represent the correct sensitivities to the climate drivers and the inherent spread of these drivers within an ensemble of climate models, develops the inherent uncertainties in the model outcomes. By using an ensemble of climate models then a signal to noise ratio can be used to display the outcomes of the model projections to decision makers.

Recently FP7 projects QWeCi in West and southern Africa and HEALTHY FUTURES in East Africa have run two dynamical malaria models, the Liverpool Malaria Model (LMM) and VECTRI (ICTP) across Africa with a range of bias corrected CMIP5 GCMs. Patterns of changes in malaria distribution in West Africa and East Africa have consistent signals seen into the future using climate model projections. The simulated malaria incidence is increasing over the tropical highlands and the uncertainties related to the disease models are generally larger than that from the climate models. The largest GCM related uncertainty is found at the arid fringes in areas, which have simulated epidemic malaria transmission. Generally the signal to noise ratios in the malaria outcomes improve with increasing projection time and also with higher RCPs.

Recently a new model the Liverpool Rift Valley fever model (LRVF) has been developed using the framework of the LMM but within much more complex model structure that includes vector models and a dynamic age stratified host model. One main task in its development was parameterising the two different behaviours of the two vectors correctly in the model whilst maintaining the correct sensitivity to the climate drivers.

For both diseases the main uncertainty lies with the future projections of seasonal rainfall patterns and the interannual and intraseasonal variations of this rainfall within the climate models. By using an ensemble of climate models to drive an ensemble of impact disease models, the Liverpool Malaria Model (LMM) and VECTRI (ICTP) give a probabilistic assessment of the model-related uncertainty of the future projections of climate–driven health hazard can be obtained.
**P-3330-01**

**Wind erosion flux and dune front dynamic at the Sahara-Sahel border: case of Kilakina (SE Niger)**

A. Abdourrahmane Touné (1); AD. Tidjani (2); JL. Rajot (3); M. Mamadou Daboua (1); B. Marticorena (4); Z. Garba (1)

(1) JEAI ADE – Geology, Université abdou moumouni, Niamey, Niger, Republic of; (2) Université Abdou Moumouni Faculté D’agronomie ; Sols, Niamey, Niger, Republic of; (3) IRD – IRD – Paris, France; (4) Laboratoire Interuniversitaire des Systèmes Atmosphériques (LISA), CNRS–UPEC–UPD–IPSL, 94010, France

Sahelian sandy soils are more sensitive to wind erosion. In the south–east Niger, the population are essentially rural and their activities are dominated by traditional breeding and agriculture developed on sandyhill soils. The region is characterized by a continuous degradation of soil structure by wind erosion. This erosion is emphasized by an important human pressure and recurrent draught witch reactivated dunes. The most productive soils lost more than a quarter of their surface in recent decades because of wind erosion which transformed cultivated area to moving dunes. This work conducted at Kilakina (SE Niger) aimed to study wind erosion and dune front dynamics of these dunes. Thus, measurements of wind erosion horizontal flux by using BSN (Big Spring Number Eight) sand catcher and dunes front dynamics have been done more than 2 years. It’s appeared that on moving dune, wind erosion had a temporal and spatial variability. Thus, the foot was eroded particularly between April and Jun while at the top of dune, wind erosion and dune movement can occur all the year at this place, the intensity of wind erosion reached close to the double of the intensity measured at the dune foot. In another way, the monsoon wind is the most agents of dunes front moving which attained a mean annual displacement near to half-meter.

**P-3330-02**

**Precipitation and disturbance as main determinant of the spatial variability of carbon fluxes in 16 West African ecosystems**

EE. Ago (1); EK. Agbossou (1); P. Ozer (2); M. Aubinet (3); EE. Ago (3)

(1) UNIVERSITY OF ABOMEY–CALAVI, Faculty of agronomic sciences, Abomey–Calavi, Benin; (2) UNIVERSITY OF LIEGE, Department of geology and geophysics and management, Liege, Belgium; (3) UNIVERSITY OF LIEGE Gembloux Agro Bio Tech, Department biosystem engineering, Gembloux, Belgium

This study reports carbon fluxes between sixteen different ecosystems and atmosphere in the West Africa region. Data were averaged at annual scale, but obtained by eddy–covariance and other indirect methods. Ecosystem types include forests, savannahs, grasslands and croplands under sudano–sahelian and guinean climates. Carbon fluxes data were recorded in the annual mean rainfall ranged between 350 (Agoufou site, Mali) and 1850 mm (ankasa site, Ghana). the total ecosystem respiration (TER) was found very highly (R² = 0.71) and Gross primary productivity (GPP) highly (R² = 0.50) correlated with the annual mean rainfall. Both TER and GPP appeared to be saturated for sites receiving annually a mean of rainfall above 1000 mm.

No clear relationship was found between these two carbon fluxes (GPP and TER) and annual temperature measures. Moreover, GPP and TER values ranged from (3.3 and 3.0) in the Sahelian fallow savannah (2.70 and 2.50 t C ha⁻¹ yr⁻¹) in the sudanian Forest, respectively. Finally, the annual carbon sequestration varied spatially according to the degree of human disturbance and ecosystem management strategy.

**P-3330-03**

**Study of CLOUDSAT products in semi-arid region of Cameroon**

A. Lenouo (1)

(1) University of Douala, Physics, Douala, Cameroon

Clouds play a major role in weather and climate processes. In this effect, a variety of satellites was put in orbit in the years 2002 to scrutinize them forming the «A-Train» providing raw data (digital data, images). This work aims to analyze and processes satellite data, preferably those in January and July 2009 in northern Cameroon from satellite data CLOUDSAT in order to explain why in this part of Cameroon, January was a very sunny month against July. The rainy months from these data (base image, applied algorithms (ECMWF–AUX, 2B–GEOPROF, FLXHR ...)) to extract reflectivity coefficient and masks clouds that cover the region of the different types of clouds which appears and their water rates. We have found that the month of July is marked by a significant presence of clouds at low, middle and vertical development (clouds rushing) against January which is marked by a very light cloud cover at higher floor. Therefore, the results of the profile vertical clouds predict the weather and climate; which equate January to July in the dry season and the rainy season respectively. These results can affect ecosystems and societal functioning, manage natural resources, agro–pastoral and economic activities over the northern Cameroon.

**P-3330-04**

**Impacts of climate variability on crop yield: how do local farmers adapt in Nigeria?**

S. Ayanlade (1)

(1) Obafemi Awolowo University, Ile–Ife, Nigeria, Dept. of Geography., Ile–Ife, Osun, France

The recent impacts of climate variability on crop yield raise the question as to whether there will be enough food in Nigeria in the next century. Various studies on the impacts of climate variability on crop yield have been carried out in different parts of the world and well established through decades of field experiments, statistical analyses of observed yields and monitoring of agricultural production by IPCC and other scholars. The majority of these studies assess inter–annual variability in the climate of West African countries, particularly the magnitude of rainfall variability impact on human activities, including crop production. Surprisingly, little systematic research has focused on the distribution patterns of the impacts of climate variability on crop production, in terms of mapping its spatiotemporal impact using the modern GIS techniques such as Kriging interpolation technique. Thus, the present study uses both Geographical Information techniques (GIS), social and demographic survey to assess the impacts and how local farmers of different demographic characteristics (through interviews) adapt to climate variability in Nigeria. The study aimed at using GIS Kriging interpolation technique together with questionnaires methods to examine and map the spatiotemporal impact of rainfall variability on crop yields in the Guinea Savanna Ecological Zone of Nigeria. Both parametric and non–parametric techniques are used for testing whether there been significant impacts and how farmers adapt to climate change/variability. The result show that modelling with a GIS offers a better mechanism to integrate many scales of data developed for agricultural research. Also the results also show that the zona variability of rainfall is observed to bring about not only the differences in the types of crops cultivated but also the rate of yield of such crops and deferent adaptation methods. The major finding is that climate change/variability has two major effects on crops. First, during the latter part of the growing season, insufficient soil moisture may restrict transpiration to well below the potential rate, with corresponding reduction in growth and yield. Second, after harvesting the crop, there will be a deep layer of soil which must be recharged to something approaching field capacity early in the following rains before satisfactory growth of the next crop can occur. The results from demographic survey using questionnaires show that local farmers have different adaptation strategies and that the variability climate implies that crop yield is exceedingly variable over space and time.
P-3330-05
Climate and climate variability: case study of the traditional lowland rice cultivation in the middle and upper Casamance Region

M. Bacci (1) ; M. Pasqui (2)
(1) Institute of Biometeorology, National Research Council, Florence, Italy; (2) Institute of Biometeorology, National research council, Rome, Italy

The Casamance Region is an enclave territory in southern Senegal that has suffered from the sociopolitical instability caused by the separatist movement for the independence of the region in the 1990s and 2000. This has led to a significant delay in infrastructure development to support the economy of the region. Nowadays, it has an unexploited potential due to a series of structural limits for the creation of an efficient supply chain for local agricultural production. The change in the security context of the region and the new Senegal rural development policies provide new opportunities for agricultural production in Casamance.

Among the various food crops, the traditional lowland rice cultivation is performed in the secondary valleys along the Casamance River, a peculiarity of the region. This crop is mainly grown to cover the food needs of the farmer's family, therefore within a strategy of food security. There are many limits to rice production in the region. The lack of mechanization, the absence of a regular distribution of improved cultivars, poor labor quality and quantity and conflicts with the livestock rearing in the valley make the system very fragile and strongly dependent on seasonal weather patterns. For these reasons, the traditional rice cultivation is becoming marginalized, with a gradual abandonment of the valleys.

In order to preserve lowland rice production and make it sustainable, an analysis of meteorological factors that most influence the crop yield aims to provide useful information for the identification of alternative cultivation strategies and implementation of direct and indirect mitigation practices on crops. The study therefore aims to assess recent climate change recorded in the region with particular attention to the parameters determining a bad or good rice crop.

Weather data from rain gauges are quite scarce in the region, often limited only to the registration of the total daily rainfall in the major towns. It was therefore chosen to use the CHIRPS daily rainfall estimate dataset that covers the period from 1981 to 2013 at 0.05° resolution. Attention has focused on assessing the fundamental parameters of the growing season such as total rainfall, number of rainy days, average daily rainfall, onset and the cessation of the growing season. In addition, we evaluated the incidence of dry periods and heavy rains during the germination and flowering period of rice, as these are the most vulnerable stages of the crop. The relationship of these parameters with large scale oceanic and atmospheric forcing was also evaluated.

The variability of these climatic parameters over time is a source of uncertainty for local farmers' decision-making process and their ability to adapt to new climatic forcing. Describing the climate, identifying observed trends and overlapping the future predictions derived from atmospheric circulation models has allowed us to define a set of future scenarios that should guide local farmers and policy makers in the orientation of agricultural development policies for the middle and upper Casamance Region.

P-3330-06
Using multi-agent simulation to assess the impact of adaptation scenario on agricultural land-use change and household food availability in northern Ghana

B. Badmos (1); G. Villamor (2); S. Agodzo (1); S. Odai (1)
(1) Kwame Nkrumah University of Science and Technology, Kumasi, Ghana; (2) Centre for Development Research, University of Bonn, Bonn, Germany

The impact of climate change and variability on the growth and development of sub-Saharan Africa (SSA) is severe. Farmers are already changing their agricultural land-use to adapt to the impacts of changing climate. In Ghana, agriculture contributes to food availability and accessibility of some food commodities consumed annually. The capability of agriculture to ensure food availability has been affected by low production, and climate change also plays a significant impact. National policies and strategies to sustain food security at a high level have concentrated on increasing domestic production. Some studies aimed at improving farm household resilience to the impacts of climate change may have implication on land-use change. Hence, adequate understanding on the impact of these policies in a temporal manner is vital.

We applied the Land Use Dynamic Simulator (LUDAS) as a MAS model to investigate the impact of farm credit as an adaptation strategy to climate variability on agricultural land-use change and farm households' food availability in Vea catchment, Upper East Region of Ghana. The model was parameterized using 186 surveyed farm households. From these households, we identified the determinants of their crop choices grouped into household characteristics (e.g., age of head, household size, dependency ratio) and farm plots characteristics (e.g., accessibility index, elevation, upslope area, plot size and proximity features). The crop choice sub-model is directly linked to an agricultural yield sub-model to determine the yields of selected crops. To adapt to climate variability in the study area, household choice of maize adoption with respect to maize cultivation credit (maize credit scenario) was integrated in the decision making and simulated for a 20-year period, and compare with the business-as-usual scenario.

Findings show that under maize credit scenario, maize adoption increased from about 20% to about 50% and the area allocated for maize cultivation significantly increased by about 266% at the expense of traditional crops. Average annual aggregated household crop yield was 6.3% higher under the maize credit scenario as compared to business-as-usual scenario. In conclusion, this study shows that access to credit can significantly influence agricultural land-use change and food availability in the study area. However, food may be available as a result of access to farm credit, but sustaining it is a big question.

P-3330-07
Comparative study of five statistical methods of climate change analysis in the Niger River basin (West Africa)

DF. Badou (1); B. Diekkrüger, (2); A. Abel (1); K. Evison (3)
(1) Université d'Abomey–Calavi, Graduate Research Program on Climate Change and Water resources, Abomey–Calavi, Benin; (2) University of Bonn, Geography, Bonn, NRW, Germany; (3) Council for Scientific and Industrial Research, Natural resources and the environment, hydrosciences research group, Pretoria, South Africa

Climate change is characterized by a significant change in the mean values of climate variables. However, detection of trends in climate variables is mostly empirical and not always easy. Two methods applied in this study, 4 commonly used statistical methods, Pettitt’s test, Lee and Heghinian’s bayesian method, Hubert’s segmentation and Mann–Kendall’s test at a significance level of 5% were compared to the cross entropy method. The latter is a stochastic optimization technique initially developed for assessing the number and the position of breakpoints in continuous biological data. From a theoretical viewpoint of statistical inference, the cross entropy method is not as powerful as Pettitt’s test and Lee and Heghinian method. However, both methods provide only one breakpoint. The Hubert’s segmentation gives multiple breakpoints but within a series even just one extreme value could result into a break. The problem can arise in series for a given level of significance. As for the cross entropy method, it provides multiple breakpoints and offers the possibility for the user to choose the number of breakpoints desired. The five methods were applied to 17 rain gauges of the Beninese part of the Niger River basin whose data cover the periods 1981–2010.
(5 gauges) and 1970–2010 (12 gauges). There was 16% of chance of obtaining a trend with the Mann–Kendall’s test. The likelihood of detecting a breakpoint with the Pettitt’s test, the Hubert’s segmentation, the Lee and Heggan’s method and the cross entropy method was 100%, 60%, 100% and respectively. We also noticed that the cross entropy method was 100% and 89% of the times able to replicate a breakpoint detected by the Pettitt and Hubert’s approaches and the Lee and Heggan’s method for the record of rainfall on 9 gauges. On the other hand, there was only 60% of chance for the Lee and Heggan’s method to reproduce a breakpoint indicated by the cross entropy method. These results suggest that the cross entropy method outperforms the 4 others and should be considered in statistical climate change studies. However, further studies are necessary to confirm the performance of the novel method in comparison to the 4 others.

P-3330-08
Latitudinal ITCZ sensitivity to the width and depth of the convective activity in WAM
M. Baldi (1) ; G. Dalu (1)
(1) Institute of Biometeorology, National Research Council, Rome, Italy

The onset of the West Africa monsoon (WAM) occurs in 2nd half of June, with a week uncertainty on the date. The onset date is defined by the date of the suddenly migration of the intertropical convergence zone (ITCZ) from the Guinea Gulf to an inland position at 5º North for two months; during this period, the convective activity weakens and the rainfall decreases. The ITCZ migration to 5º North is observed by satellites as an Orl minimum and as a rainfall maximum over the Guinea Gulf. Towards the end of June, the convective activity weakens over the Guinea Gulf, to crop out few days 5º further inland.

The mechanisms which accompany the development of WAM are rather complex, thus a simple model for the ITCZ behavior is not yet available. One could however refer to the literature of this peculiar behavior of the ITCZ in WAM is the positive feedback between the deepening of Saharan low at the time of the onset and the confining action of the inland orography to the ITCZ inland penetration. An other confining action can exerted by the presence of inland critical lines for propagating easterly wave.

We propose a mechanism which can concur to this sudden latitudinal jump of the ITCZ. Following results found in the literature of a latitudinal ITCZ sensitivity to the shape of the forcing, using a Matsuno–Gill model, we show that the widening of convective activity is accompanied by a temporary weakening of the convergence 5º North, followed by a strengthening of convergence at 10º North, when the width of the convective activity exceeds one Rossby radius. On the other hand, the ITCZ transition is rather rapid, this is when the convergence maximum settles at one Rossby radius North of the equator. This mechanism the ITCZ migration is complementary to other mechanisms and the feedback between different mechanisms might be difficult to model in terms of simple theory.

P-3330-09
Climate change in a tropical region: the case of LAMTO reserve in Côte d’Ivoire
K. Benjamin (1) ; F. Yore (1) ; A. Diawara (2) ; Y. Kouadio (1)
(1) University Felix Houphouët Boigny – Cocody – Abidjan, Physic, Abidjan, Ivory Coast; (2) University Felix Houphouët Boigny – Cocody Abidjan, Physic, Abidjan, Ivory Coast

LAMTO reserve is located on the center of Côte d’Ivoire in West Africa. Climate variability of LAMTO reserve was studied over the period from 1962 to 2010 (49 years). This study uses climatic data (precipitation and temperature) measured on LAMTO geophysical station. In general, rainfall decreased in the reserve. Compared to the average of the 49 years, the region recorded a rainfall deficit over thirty years (1971 to 2000). This deficit was more pronounced during the 90s. On the over side, during the period 2000 to 2010, the rainfall increased.

The region recorded an increase of the mean temperature (+1.4°C) compared to 1960s. This is a sign of global warming. In contrast, from 2001 to 2010, the average minimum temperature decreased (-2.43°C). In fact, this fall causes the decrease of the average mean temperature (-1.25°C) of this decade.

P-3330-10
Recent rainfall variability and vegetation activity in the experimental site of the Upper Ouémé basin (Benin)
S. Bigot (1) ; T. Do (1) ; B. Dieppois (2)
(1) Laboratoire d’étude des Transferts en Hydrologie et Environnement (LTHE), Université Grenoble Alpes, Grenoble, France; (2) Coventry University, Centre for agroecology, water and resilience, Coventry, United Kingdom

From the late 1990s, the Sudano–Sahelian zone is, a priori, wetter than during the two previous decades, which were marked by the development of persistent droughts. This recent evolution is likely to influence local to regional climate and, thus the vegetation cover, the biomass and seasonal phenology in the forest and savannah belt. Contrasted results in simulating the future regional climate trends, however, leaves the future of West African environments widely open and uncertain. Accurate in-situ monitoring is therefore needed to increase knowledge and understanding of West African climate variability.

We propose a mechanism which can concur to this sudden latitudinal jump of the ITCZ. Following results found in the literature of a latitudinal ITCZ sensitivity to the shape of the forcing, using a Matsuno–Gill model, we show that the widening of convective activity is accompanied by a temporary weakening of the convergence 5º North, followed by a strengthening of convergence at 10º North, when the width of the convective activity exceeds one Rossby radius. On the other hand, the ITCZ transition is rather rapid, this is when the convergence maximum settles at one Rossby radius North of the equator. This mechanism the ITCZ migration is complementary to other mechanisms and the feedback between different mechanisms might be difficult to model in terms of simple theory.

The recent period (2001–2013), which displays annual rainfall amounts of about 934 to 1302 mm in 2001 and 2010 respectively, is characterized by a ‘climatic or climatic degradation’ versus ‘climatic or non-climatic greening’ by the current conceptual modelling studies. We focus on the 2001–2013 period using in-situ rainfall gauges from AMMA–CATCH, 10-day rainfall estimates from satellite data (RFE; 8 × 8 km), and 5-day photosynthetic activity (NDVI EROS–MODIS; 0.5 × 0.5 km). Although monthly rainfall amounts are underestimated in the RFE data, the co-occurrence of AMMA–CATCH and the RFE dataset are highly correlated (R = 0.93), which ensures a good reproduction of the year–to–year variability.

The recent period (2001–2013), which displays annual rainfall amounts of about 934 to 1302 mm in 2001 and 2010 respectively, is characterized by a ‘climatic or climatic degradation’ versus ‘climatic or non-climatic greening’ by the current conceptual modelling studies. We focus on the 2001–2013 period using in-situ rainfall gauges from AMMA–CATCH, 10-day rainfall estimates from satellite data (RFE; 8 × 8 km), and 5-day photosynthetic activity (NDVI EROS–MODIS; 0.5 × 0.5 km). Although monthly rainfall amounts are underestimated in the RFE data, the co-occurrence of AMMA–CATCH and the RFE dataset are highly correlated (R = 0.93), which ensures a good reproduction of the year–to–year variability.

The recent period (2001–2013), which displays annual rainfall amounts of about 934 to 1302 mm in 2001 and 2010 respectively, is characterized by a ‘climatic or climatic degradation’ versus ‘climatic or non-climatic greening’ by the current conceptual modelling studies. We focus on the 2001–2013 period using in-situ rainfall gauges from AMMA–CATCH, 10-day rainfall estimates from satellite data (RFE; 8 × 8 km), and 5-day photosynthetic activity (NDVI EROS–MODIS; 0.5 × 0.5 km). Although monthly rainfall amounts are underestimated in the RFE data, the co-occurrence of AMMA–CATCH and the RFE dataset are highly correlated (R = 0.93), which ensures a good reproduction of the year–to–year variability.

The recent period (2001–2013), which displays annual rainfall amounts of about 934 to 1302 mm in 2001 and 2010 respectively, is characterized by a ‘climatic or climatic degradation’ versus ‘climatic or non-climatic greening’ by the current conceptual modelling studies. We focus on the 2001–2013 period using in-situ rainfall gauges from AMMA–CATCH, 10-day rainfall estimates from satellite data (RFE; 8 × 8 km), and 5-day photosynthetic activity (NDVI EROS–MODIS; 0.5 × 0.5 km). Although monthly rainfall amounts are underestimated in the RFE data, the co-occurrence of AMMA–CATCH and the RFE dataset are highly correlated (R = 0.93), which ensures a good reproduction of the year–to–year variability.

The recent period (2001–2013), which displays annual rainfall amounts of about 934 to 1302 mm in 2001 and 2010 respectively, is characterized by a ‘climatic or climatic degradation’ versus ‘climatic or non-climatic greening’ by the current conceptual modelling studies. We focus on the 2001–2013 period using in-situ rainfall gauges from AMMA–CATCH, 10-day rainfall estimates from satellite data (RFE; 8 × 8 km), and 5-day photosynthetic activity (NDVI EROS–MODIS; 0.5 × 0.5 km). Although monthly rainfall amounts are underestimated in the RFE data, the co-occurrence of AMMA–CATCH and the RFE dataset are highly correlated (R = 0.93), which ensures a good reproduction of the year–to–year variability.
ABSTRACT BOOK

followed from there.

overexploitation of the natural environments which was

of a supplement of the environment degradation in

niamey since the 2000s, even if this region experiences

in another source area, which could be more fragile

the sahelian region was caused by the particles mobilized

that tried to the consequence

haze increase particularly since 1967.

However horizontal visibility decreased in Bilma by sandy

of weather types associated to low visibilities (sandy haze).

2009) is also marked by an increase in daily occurrences

and dust haze. During the dry season, we note an increase

visibility (and associated weather types: blowing sand,

at the interannual timescale, decreasing horizontal

is likely to reduce horizontal visibility during the dry, the

soil and by blocking dynamically a part of the dust

rainy season actsto reverse this trend by moistening

e.g., due to increasing soil erosion and particle transport,

visibility is decreasing during the dry season (October to

impacts of other pressures. Climate change affects

natural forest (forest reserves) areas and those undergoing

transformed into farmland (crop-growing and fallow

land) is very clear. More accurate spatio-temporal analyses

(6am, 12pm and 6pm) of horizontal visibility and wind, and daily rainfall

wind speed variability have been examined. Over a NE-

3-times daily measurements (i.e., 6am, 12pm and 6pm) of horizontal visibility and wind, and daily rainfall

between February and August.

At the interannual timescale, decreasing horizontal

visibility over the Sahel is linked to increasing occurrence of specific weather types, such as blowingsand, sandy haze and
dust haze. During the dry season, we note an increase in wind speeds between the wet period (1950–1969) and the dry period (1970–2009), which is associated with a
decrease in horizontal visibility. The dry period (1970–
2009) is also marked by an increase in daily occurrences of weather types associated to low visibilities (sandy haze).

However horizontal visibility increase in Bilma by sandy

haze increase particularly since 1967.

One could think that the mechanisms of the climate change are earlier than what is generally admitted in rainfall evolution onms. These mechanisms would first affect zones that are most sensitive to wind erosion. In Bilma, it is also observed that the increase of the blowing sand, originating particles in suspension is significant before the drought of 1973. Is it thus also possible that increasing dust in the Sahelian region was caused by\n
Vegetative species diversity is essential for human well-

being because it provides services, such as food, medicines,
clean water and soil stabilization within a catchment or

sub-catchment. However, it is under threat from climate change which poses a challenge by exacerbating the

impacts of other pressures. Climate change affects
different ecosystems in different ways, depending on the complexity and original characteristics of the system, geographical location and presence of factors that may regulate the extent of the changes. In southern Africa in general and Zimbabwe in particular, there is still paucity of understanding of climate change’s impact on vegetative species diversity specifically species richness and evenness. A plethora of studies have claimed that climate change affects biodiversity but without focusing on species diversity indices. This poses challenges in designing adaptive and mitigative strategies that are ecosystem and species specific. This study assesses the effects of climate change on vegetative species diversity in Mutirikwi sub-catchment using the Normalised Difference Water Index (nDWI).

To achieve the research objective, the relationship between vegetative diversity indices (richness and evenness) and climatic variables (rainfall and temperature) was explored based on species data directly collected from the field over a 3 year period and climate data collected from three local stations (Makoholi, Masvingo airport and Buffalo range). Relationship between nDWI and species diversity indices was examined to confirm the utility of remote sensing in predicting vegetative diversity. nDWI was calculated using the formula:

$$NDWI = \frac{(\text{NIR} - \text{SWIR})}{(\text{NIR} + \text{SWIR})}.$$  

Where \(\text{NIR}\) and \(\text{SWIR}\) are the reflectances of the near-infrared (NIR, 0.78~0.89 m) and shortwave-infrared (SWIR, 1.58~1.75 m) regions, respectively.

The species diversity indices were calculated using the Shannon Weaver index which usually combines aspects of richness and evenness. This index was calculated using the formula:

$$H = -\sum (p_i \ln(p_i))$$  

Where the summation is over all species and \(p_i\) is the relative abundance of species in the quadrat. This index measures the average degree of uncertainty in predicting to what species chosen at random from a collection of \(S\) species and \(N\) individuals will belong. Species evenness \(E\) was calculated using the formula:

$$E = H/\ln(S)$$  

Where \(H\) is the Shannon Weaver index and \(S\) is species richness observed within the quadrat.

The resultant predictive model was used to estimate changes in species diversity over a 40 year period (1974~2014). The species diversity data was then regressed with climatic data for the same period. These data were also modelled to project future changes in vegetative diversity in the face of climate change.

Preliminary findings reflect a significant \((P<0.05)\) correlation between species diversity and climatic variables. The results also indicate that there is a significant \((P=0.003; \alpha=0.05)\) relationship between species richness and nDWI. Species evenness was also significantly correlated \((P=0.04; \alpha=0.05)\) with nDWI. This implies that we can use nDWI to assess changes in species diversity over time. The Mann Kendall test revealed a significant relationship between rainfall and maximum temperatures over the period (1974~2014). The minimum and maximum temperatures over the period were significantly increasing. These changes in climatic variables were matched with a decrease in species richness and evenness.

Some species tend to be succumbing to the environmental changes influenced by climate change resulting in their changes in phenology, abundance and distribution.

The study concludes that climate change in Mutirikwi sub-catchment is influencing species diversity through changing the phenological features, abundance and distribution. Besides being a good indicator of water content in leaves, nDWI has proved to be a useful indicator of species diversity. The study leads to the understanding of the relationship between vegetative species diversity and climate change and this provides a platform for nations to devise strategies to enhance the resilience of ecosystems to climatic changes through the adoption of species based adaptive and mitigative strategies.

**P-3330-15**

**Responding to Climate Change Challenges in Sub Saharan Africa - A case for Water Supply**

P. Chukwuma (1)

(1) Sustainable Water and Sanitation in Africa, Abakaliki, Ebonyi State, Nigeria, Federal Republic of

Change is a permanent phenomenon in all spheres of life. Many a time changes present both opportunities and threats. For instance, climate change is a result of human activities, which presents challenges to constantly anticipate changes and their impact. Some changes come with heavy impact. Climate change is one of them. It has spiral effect on several frontiers of human existence. It is one phenomenon that deserves urgent attention. Based on risk assessment, we need to take proactive steps to either eliminate adverse impacts or mitigate them or compensate for the perceived impacts. Sometimes, changes present beneficial opportunities. In dealing with changes, time of reaction and availability resources are vital.

Sub Saharan Africa Countries are presently existing on fragile economy. Population is increasing while social infrastructures are dwindling. This presentation outlines the challenges of dealing with climate change in Sub Saharan Africa. I analysis the following issues as it relates to climate change:

- Threats of climate change
- Opportunities occasioned by climate change
- Capacity to respond to climate changes
- Effect of climate change
- Consequence of climate changes in Sub Saharan Africa
- Strategy to coping with climate change challenges
- Risk identification
- Stakeholders communication strategy

The paper asserts that Sub-Saharan Africa remains the most vulnerable region in Africa due to inherent poverty and lack of clear policies on dealing with climate change. Climate change will have adverse impacts leading to decreased food production, displacement, increased poverty, conflicts and reduction in production capacity in the region. Although, some parts of Sub Saharan Africa will experience increased agricultural production as a result of increased rainfall but there exist little capacity to take maximum advantage of the opportunity or mitigate the adverse impact of excessive rainfall. Generally, climate change portends a bleak future for Sub Saharan Africa. The paper posits that Sub Saharan Africa countries need to take urgent actions towards tackling the threats of climate change and plan on take advantage of emerging opportunities.

The paper elicits that climate change challenges in Sub Saharan Africa will adversely affect other regions of the world in one way or the other.

**P-3330-16**

**The impact of global changes on agriculture: the case of Ivorian Basin of Comoé River**

N. Dabissi (1); L. Bruno (2); M. Gil (3); B. Kamagate (1); S. Eríc (4); B.T. Goula (1); S. Issiaka (1)

(1) Université Nangui–Abrogoua, Ufr sge, Abidjan, Ivory Coast; (2) 2CIRAD TA 60, G-Eau, UMR Cemagref, Montpellier Cedex 05, France, G-eau, umr cemagref, cirad montpellier, MONTPELLIER; France; (3) Université Montpellier 2, Hsim/ird, MONTPELLIER, France; (4) Université de Franche-Comté, EPST, F-25000, Besançon, France

Since some decades, the Ivorian Comoé river Basin faced environmental and climatic changes. As one of rainfall agriculture leading forces, climate conditions display (here) a major role in agriculture transformations. The simulation of water need requirements, coupled with farming systems, shows that actual global changes mainly benefit to annual crops such as corn (Zea mays), and allows the upgrading of the rice crop as cashew (Anacardium occidentale), rubber tree (Hevea brasiliensis), etc. However, the precariousness of the production systems, whose practices have not developed changes, has to be linked with the combined effects of land saturation, agricultural policies and need of cash faced by farming communities. Therefore, the diversification and reconversion toward rubber plantation, are to be considered as farmers’ strategies aiming at finding alternatives for old speculations such as coffee.
(Coffea L.) and cocoa (Theobroma cacao L.). For instance, the countryside has been gripped by a frenzy of agricultural development of Chromolaena Odorata and wetlands, which were previously not cultivated. These changes go with intense competition for land that benefits some urban elites who seek to invest in rubber plantation (Hevea brasiliensis). We are witnessing social and spatial reconstructions that, in view of the uncertainty of present conditions, leave small room for the protection of ecosystems. This means that the ongoing processes, speculates on their future development, and suggests some ways for sustainable agriculture.

P-3330-17

Impacts of climate variability and agricultural intensification on the origin of runoff: the case study of the watershed Kolondieba in the south of Mali

A. Dao (1) ; B. Kamagate (2)

(1) Université Nangui Abrogoua, Laboratoire de Géosciences et Environnement, Abidjan, Ivory Coast; (2) Université Nangui Abrogoua, Laboratoire de géosciences et environnement, Abidjan, Ivory Coast

As part of the international research program RIPIECSA (Interdisciplinary and Participatory Research on Interactions between Ecosystems, Climate and Society in Africa), water harvesting in the Gobin (under sandy soil and the Sahelian climate) was selected to understand the mechanism of runoff process in order to improve hydrological model in a context of strong climate variability and agricultural intensification contexts in the Sahel. The method used is based on rainfall, hydrometric, geochemical and piezometric data monitoring over the period 2009-2011. The results showed that 2009 and 2010 were normal rainfall years (300–400 mm), while 2011 had a reduced rainfall compared to the average of chronic 1960–1969 (wet period), while 2011 has emerged as a dry year compared to the chronic 1992–2009 (dry period). During the contrasted two years, the runoff coefficient has decreased by half from 2010 to 2011 occasioned groundwater discharge deficit estimated at 33%. Monitoring the mineralization of targeted water compartments, the surface water, and groundwater with the integrator chemical parameter (Electrical Conductivity), showed a very little mineralization of rainfall with an average of 16.99 ± 8.53 μS cm⁻¹. The contribution has increased by 3% in dry year (2011). In these conditions runoff doesn’t depend only on rainfall variability, it can be assigned to the land use because cotton culture is increasing on the basin since 1960.

P-3330-18

Climate projections in West Africa: evidence and uncertainties

A. Deme (1) ; AT. Gaye (2) ; F. Hourdin (3)

(1) Gaston Berger University of Senegal, Applied Sciences and Technologies, Saint-Louis, Senegal; (2) University Cheikh Anta Diop Dakar, Laboratory of atmospheric and ocean physics, Dakar, Senegal; (3) IPSL–LMD, Paris, France

The Sahelian Africa response to global warming was uncertain in the models of the third phase of the Coupled Model Intercomparison Project (CMIP3) used for the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC), which even disagree on the sign of future rainfall anomalies over this region. This disagreement remains even among models that correctly simulate the twentieth–century West African climate. Our study involves four members of the ensemble of state–of–the–art climate models which participated of the fifth phase of CMIP (CMIP5) and raises several questions. Do the models agree more on Sahelian Africa rainfall projections? Do they well simulate the partial rainfall recovery observed over the last decades? How well are models able to reproduce the main features of the West African Monsoon (WAM)?

P-3330-19

Why is the « Sahelian paradox » recently exacerbated?

L. Descroix (1) ; JP. Vandervaeve (2) ; H. Dacosta, (3) ; M. Malam Abdou (4) ; A. Diongue Niang (5) ; A. Bodian, (6) ; T. Sané, (7) ; V. Tarchiani, (8) ; P. Vignaroli, (8)

(1) IRSN, Palais de l’Innovation, Centre National de Recherches sur l’Environnement et l’Hydrosphère, Université de Paris, Saint-Denis, France; (2) LTH–UJF, Grenoble, France; (3) Université Cheikh Anta Diop, Dept of geography, Dakar, Senegal; (4) Universite de Zinder, Dept of Geography, Zinder, Niger; (5) Centre Interdisciplinaire de Climatologie, Dakar, Senegal; (6) Université Gaston Berger, Dept of geography, Saint Louis, Senegal; (7) Université Assane Seck, Dept of geography, Ziguinchor, Senegal; (8) CNR, Ibitem, Firenze, Italy

During the Great Drought that West Africa suffered at the end of the 20th century, hydrological observations highlighted an increase in runoff on the northern parts, although this was the area where the rainfall deficit was the highest. From the small experimental plot to the major tributaries basins of the main rivers, runoff coefficients and recharge values increased significantly during the dry period. This was named the « Sahelian Hydrological Paradox ». From the very end of the century, after 1995, rainfall generally increased again in the whole West Africa. Therefore, an increase in runoff after 1995 is easy to explain. However the increase in runoff and discharges values began in 1970, at the very beginning of the Great Drought; the hydrological behavior of Sahelian surfaces remains thus paradoxical at least from 1945. Thus its recent exacerbation is not such paradoxical, yet needs to be explained.

The more commonly cited Sahelian paradox explanation is the widespread soil crustting through the Sahel. It is considered as a consequence of the extension of crops, leading to a quasi–disappearance of natural bushes. This trend was accompanied by increasing the main fertility restoration practice used in the Sahel. After 3–4 years of cropping, a 8–10 years fallingow was traditionally practiced. The population increase and subsequent food needs progressively led to the
abandonment of this practice, and then to a decrease in crop yields and a general soil degradation (structure, water holding capacity, fertility, OM content, etc.). This was for long way considered as the main cause of soil crust. Soil crust and its consequence the runoff coefficient rise were detected within in exorheic areas as well as within endorheic ones. In the latter, it caused an extension of ponds, which are the main groundwate recharge sites, and then it led to a rise in water table levels. The rise in local runoff due to soil crust was sufficient to provoke the change of someendorheic areas into exorheic ones: the overflowing of some ponds effectively transformed closed valleys into tributaries of the Niger River. In the sole Niger area are 5,000 km² of closed valleys which are supplementary groundwater recharge sites added to the known previous basin; this is close to 50% of the direct catchment of the Niger River in this region (small basins directly supplying the Niger River, without main tributaries). Locally, urbanization should also explain an increase in runoff, because it leads to a decrease in soil permeability (buildings, roads, etc.). Otherwise gutters are not always maintained and in many case there were released, their overflowing aggravating then the flood. Recent flooding of capital cities without rivers (Ouagadougou in 2009; Dakar in 2012 amongst others) proved that a purely urban cause of increasing runoff is possible.

A recent observation of an increase in frequency of extreme rainfall events has been considered as a factor of increase in runoff coefficient and flooding. So far, neither the number of rainy events above certain high thresholds of daily amount, nor the amount of rain fallen during these events has halved until 2014 exceeded those observed during the 1950s and 1960s decades, before the beginning of the observed increase in runoff coefficients. An intensification of rainfall is observed, however it is evidenced only by the increase in the proportion of rainfall amount observed during high rainfall amount events (commonly named extreme events).

The annual flood does not always provoke inundations; however, floods can evolve in inundation owing to at least two series of factors: the silting up of river beds led to a decrease in soil permeability (buildings, roads, etc.) during replanting. agro-climatic data were collected at the cocoa research station of Divo and Gagndindu.

Soil crust and then land use changes seem to be the main explaining factors of increase in runoff. Therefore it is important for policy makers to be sensitized about the effects of consequent land use changes on the hydrological regimes of Sahelian rivers.

**P-3330-20**

Impact of climate changes in the last thirty years on the second generation of cocoa in Ivory Coast

A. Diedhiou (1); E. Kassin Koffi (2); GF. Yao (2); LKA. Koko (3); AA. Assiri (3); B. Kouame (2); A. Konaré (4); NK. Kouassi (5); CR. Yoro (2) (1) Institut de recherche for Development (IRD), LTHE – University Grenoble Alpes, Grenoble Cedex 9, France; (2) National Center of Agronomic Research (CNRa), Central laboratory of soil, water and plants, Bouaké, Ivory Coast; (3) National Center of Agronomic Research (CNRa), Central laboratory of soil, water and plants, Bouaké, Ivory Coast; (4) University Felix Houphouet Boigny, Laboratoire de physique de l’atmosphere et de mecanique des fluides, Abidjan, Ivory Coast; (5) National Center of Agronomic Research (CNRa), Central laboratory of biotechnology, Abidjan, Ivory Coast

The Ivorian cocoa sector is facing in the recent three decades a tree crisis due to the shortage of new generation of cocoa due to changes in the annual cumulative rainfall and the inadequacy of the current crop calendar in the present climatic context. This study, conducted in the coco-watering project (2010-2013) was to assess climate risks for cocoa and determine the suitable period to establish new cocoa farm and to ensure the survival of young trees during replanting. Agro-climatic data were collected at the agronomic research station of Divo and Gagndindu. The comparison between climatic parameters and the water needs of cocoa shows that the favorable period of implementation of cocoa in the current climate context of the study area is between March and April and not between May to June as recommended since the 1960s, to enable young trees to take advantage of the long rainy season that occurs earlier. A strategy of implementation the second generation of cocoa taking into account the climate change observed over the region is proposed.

**P-3330-21**

Determination of malaria parameters using meteorological data sets of Senegal stations and reanalyses products

I. Diouf (1); AT. Gaye (2); A. Deme (2); JA. Ndiene (3); B. R. F. (4) (1) University UCAD, Lab. of atmosphere and oceanic physics, Dakar, Senegal; (2) Gaston Berger University of Senegal, Applied Sciences and Technologies, Saint-Louis, Senegal; (3) Centre de Suivi Ecologique, Dakar, Senegal; (4) Universidad Complutense de Madrid, Facultad de fisicas departamento de meteorologia, Madrid, Spain

Climate behavior is an important factor for malaria development, a vector-borne disease which is a really public health problem, particularly in Sub-Saharan part of Africa. High temperatures are favorable for the quick growth of mosquitoes and the shortening of the reproductive cycle of the pathogen known as plasmodium, while the proliferation of vectors in breeding sites is driven by precipitations. Due to difficult access of observations datasets, this study has a huge component of simulations of malaria parameters using the Liverpool Malaria Model (LMM) developed by Hoshen et al (2004). The inputs of the model are meteorological data of stations and different reanalyses products. The results of this study show that a two-month lag is often observed between the maximum of precipitations and the peak of malaria incidence in Senegal. Malaria occurrence period is centered on the September–October–November period corresponding to the end of the rainy season warm and humid. These findings are highlighted both with stations datasets and reanalyses.

Otherwise, this study attempts to assess the impact of past, present and future climate features on vector-borne diseases such as malaria. Our findings about malaria changes under climate change will be useful in order to prevent malaria outbreaks due to high probability of climate change.

These results taking account the main climate and environmental behaviors could be useful in the prevention of malaria in Senegal and elsewhere.

**P-3330-22**

Climate variability and its role in accessibility to and use of water: social and health issues in informal settlements in Ouagadougou (Burkina Faso)

S. Dos Santos (1); FDC. Ouédraogo (2); BA. Soura (3) (1) IRD, LPED (AMU/IRD), Ouagadougou, Burkina Faso; (2) Université de Ouagadougou, Géographie, Ouagadougou, Burkina Faso; (3) Université de Ouagadougou, Département de sociologie et de sciences de la population, Ouagadougou, Burkina Faso

Expected changes to the global environment have led to a burgeoning literature on climate change vulnerability and adaptation. A part of this literature focuses on developing high-resolution climate change projections to assess risks to different regions. Due to the uncertainty in the regional climate projections offered to decision-makers – the “top–down” methods. Another part of the literature addresses past and present climate variability and aims to assess vulnerability, in a “bottom-up” approach. As social scientists, we want to contribute to this second part of the literature, as we agree with the geographer Richard Washington and his colleagues that, coping with present and future climate change, is itself enough of a challenge. In this communication, we wanted to document the diversity and the variability of access to water depending on the variability of the climate (across seasons) in an African capital-city characterized by both population and spatial expansions.

Indeed, better access to water is as much a factor conducive to development as its result. Improved water
access has many effects on human health. This effect is magnified by both the quality and the quantity of water available in a household. Greater quantities of water and a reduction in the risk of water contamination are two principal means of preventing the diseases transmitted through the faecal-oral route, such as diarrhoea, which are a leading cause of death among children in sub-Saharan Africa. Nevertheless, in terms of water access, sub-Saharan African cities are some of the worst off in the developing world. However, the absence of a public water supply means that the247s, the break of ways and bridges under the influence of the phenomenon of the erodibilité provoked by runoff water. Today, it is about develop or to make developments which are capable of adapting itself to the current climatic evolution of the context and future.

P-3330-24

Diffusion and scaling of Soil and Water Conservation measures to manage Climate Change in Nigeria

J. Ezeji (1)

(1) Rural Africa Water Development Project (RAWDP), Water Resources and Supplies, Owerri, Imo, Nigeria, Federal Republic of Nigeria

Throughout Nigeria, small holder farmers are increasingly affected by extreme climate and environmental change events. Worsening droughts in particular is ruining the lives and livelihood of many small holder farmers as it continued to hamper farming activities. Their albatross includes water mismanagement, inappropriate land use, as well as poor knowledge of anti-drought measures and this has led to land degradation such as soil erosion and loss of the soil’s productive capacity to produce food.

Also the limited potential for dry season farming through soil and water conservation, the non-employment of rain water harvesting technology, as well as conflicts over limited water resources have not helped the situation. Consequently, local livelihoods are being jeopardized while increasing poverty for thousands of these farmers expands.

The paper therefore reviews the adoption and scaling of the World Overview on Conservation Approaches and Technologies (WOCAT) technologies and measures based on the fact that it offers a basket full of Soil and Water Conservation measures that work under specific or under a range of conditions. Soil and Water Conservation (SWC) in this context include the prevention or reduction of soil erosion, compaction and salinity, conservation or drainage of soil water; maintenance or improvement of soil fertility, etc.

The paper also documents, evaluates, compares, monitors and analyses the performance of these WOCAT technologies and approaches such as agronomic, vegetative, and structural and management measures that have proven capable of controlling soil degradation and enhance productivity in the field under existing environmental and climatic variations.

It recognizes and acknowledges the challenge and importance of adapting to climate change. Thus, standardized documentation and evaluation of approved as well as innovative land management technologies and approaches, taking into consideration their adaptation potentials and tolerance towards possible scenarios of climate change, builds the basis to get prepared for the future.

Using the WOCAT methodology, this paper discusses how small holder farmers in eastern Nigeria, whose livelihoods are based on small-scale farming, are achieve a sustainable harvest and use rain water through agronomic, vegetative, and structural measures. It underscores the sheer grit, courage and the determination this vulnerable group has to do all in the face of the threat of survival. It further underscores that --individually, households and communities are not passive in the face climate change, and even economic change.

P-3330-25

Managing water and nitrogen fertilizers in maize production for smallholder farmers’ resilience to climate change impacts

IR. Fandika (1)

(1) Department of Agricultural Research Services, Kasinthula Research Station, KASINTHLA RESEARCH STATION,

Rainy extreme events and phenomenon of flood in the city of Cotonou (Benin): Measure of protection and adaptation of the population

CG. Etene (1)

(1) Université d’Abomey-Calavi, Géographie, Cotonou, France

More and more, because of the climate change, the populations have to resist frequent and extreme meteorological phenomena, greater climatic variability and changes of the climatic standards. In Benin and more especially Cotonou, the pluvimetric and infrastructural data are used. The statistical analysis was used to determine the extreme rains. The socio-anthropological inquiries will allow to determine the perceptions of the population on their states of vulnerabilities to the phenomenon of floods and to see that they are the strategies of possible adaptation.

The results of this study show that the populations with average income, the socio–urban equipment’s and houses are the most exposed to the phenomena of floods. This vulnerability is often understandable by the collapse of certain houses, the break of ways and bridges under the influence of the phenomenon of the erodibilité provoked by runoff water. Today, it is about develop or to make developments which are capable of adapting itself to the current climatic evolution of the context and future.
CHIKWAWA, Malawi

Water scarcity is one of the most limiting factors for maize production in Malawi, especially the areas that are vulnerable to climate change. Irrigation alone without proper soil-nutrient management fails to enhance maize yield. Participatory embrace of efficient water and nutrient management strategies from on-farm to station to on-farm would help farmers build resilience to the impacts of climate change. This paper discusses how development and dissemination of efficient water management strategies in maize can adapt smallholder farmers to climate change. Irrigation scheduling techniques combined with nitrogen rates and the use of maize varieties efficient in water use were participatory assessed from on-station to on-farm in comparison with farmers’ practices. Alternate furrow irrigation technique was evaluated at on-farm in a randomized complete block design (RCD) replicated experiment with three irrigation scheduling treatments: (1) Alternate Furrow Irrigation (AFI); (2) Fixed Furrow Irrigation (FFI) and Convention Furrow Irrigation or farmer practice (CoFI). The ten-year rate of change is generally between 161.11% and 616.67%. Thus, compared to the first decade (1960–1969), weather–related disasters are multiplied by at least 2 during other decades and even more during the 2000s (by about 6 for all climate disasters and 7 for floods specifically). In some areas (large cities like Douala and Yaounde, the Sudano-Sahelian plains of the Logone and Benue), recurrent climate disasters were recorded at the same periods of the year with rising intensity and higher damages each time. The government is aware and concern is shown at the highest level. In August 1988 and August 2012, the president of Cameroon, Paul Biya, visited the same places hit by floods in the Sahelian part of the country. Relief type responses like evacuation of populations, accommodation in camps, comfort visits, donations in materials and money are the type of measures taken through the government. This results in a variety of climates determined by its location on the Atlantic ocean, its extension in latitude from 02 ° to 13 ° N, and its varied landscape. As a young country with low-middle income, Cameroon is highly vulnerable to natural hazards, particularly to those related to climate variability and change (World Risk Report, 2014). This results in a variety of climatic disasters which unfortunately recur every year, usually at the same places and during the same periods of the year despite responses from the State and its partners. Therefore, the efficiency of strategies and adaptation approaches in place ought to be questioned. This paper aims at making a comprehensive assessment of the government’s approach to adapt to recurring impacts of climate variability and change in Cameroon. At first, we list climate disasters recorded in the archives between 1960 and 2012 in Cameroon and on-farm. In the second part, we list events at specific locations and time of the year. Following this historical review, we analyse recurrent disasters for each decade and the rate of change of the occurrence of climate disasters between the first decade and the other periods. Finally, through content analysis, we review the types of responses implemented by the State to address these impacts and the consideration given to them. For this study, we participated in the government’s national adaptation plan (NAP) and a process to develop a National Adaptation Programme of Action (NAPA) and a National Adaptation Plan (NAP). A process to develop a few strategies and plans in place but is still not finalized because of the weaknesses of the legal and institutional frameworks as well as inappropriate methodologies. Meanwhile, disasters and other climate change impacts are increasing and the government is taken unaware most of the time! The recurrence of climate disasters in Cameroon is thus a consequence of poor adaptation to the impacts of climate change, the strategy in place being more oriented to measures after blows instead of anticipated or planned medium and long term strategies at national level.
Water Resources Management in the Sahel region, West Africa, is extremely difficult because of high inter-annual rainfall variability. Unexpected floods and droughts often compromise economic activities and sometime lead to severe humanitarian crises. This is exacerbated by endemic poverty, preparedness to disaster response, the inadequacy of climate information, and weak institutional capacity. All these factors worsen the vulnerability of sub-Saharan Africa countries to climate changes and make the region, regions of which are highly impacted worldwide. Seasonal rainfall forecasting is one possible way to increase resilience to climate change/variability by providing information in advance about the amount of rainfall expected in each upcoming rainy season. Rainfall forecasting models are often arbitrarily assumed that rainfall is linked to predictors by a multiple linear regression with parameters that are independent of time and of predictor magnitude. Two probabilistic methods based on change point detection that allow the relationship to change according to time or rainfall magnitude were developed in this paper using Normalized Bayes Factors. Each method uses one of the following predictors: Sea Level Pressure (SLP), Air Temperature (AirTemp) and Relative Humidity (RHUM). Method M1 allows for change in model parameters according to annual rainfall magnitude, while model M2 allows for changes in model parameters with time. M1 and M2 were compared to the classical linear model with constant parameters (M3) and to the climatology (M4). Results showed that model which allows a change in the predictor magnitude and relationships according to time and rainfall magnitude (M1) and using AirTemp as predictor is the best model for seasonal rainfall forecasting in the study area.

P-3330-29
The competitive impacts of global SST warming and CO2 increase on Sahelian rainfall: results from CMIP5 idealized simulations

M. Gaetani (1); C. Flamant (1); F. Hourdin (2); S. Bastin (1); P. Bracnot (3); S. Bony (2)

(1) IJPS-LATMOS, Paris, France; (2) IJPS-LMD, Paris, France; (3) IJPS-LSCC, Gif-sur-Yvette, France

The West African Monsoon (WAM) is affected by large climate variability at different timescales, from interannual to multidecadal, with strong environmental and eco-economic impacts associated to climate-related rainfall variability in Sahelian countries. Sahelian West African climate models still show poor ability in correctly simulating the WAM historical variability and also a large spread is observed in future climate projections. In this work, climate simulations from a set of 10 CMIP5 atmospheric global climate models are used to study the July–September WAM variability in the period 1979–2008. The individual roles of global SST warming and CO2 concentration increase are investigated through idealized experiments simulating a 4K warmer SST and a 4x CO2 concentration, respectively.

Results show a dry response in Sahel to 4K SST warming, with dryer conditions over western Sahel. On the contrary, wet conditions are observed when CO2 is 4x increased, with the strongest response over central–eastern Sahel. The precipitation changes are associated to coherent modifications in the regional atmospheric circulation: dry (wet) conditions are associated with reduced (increased) convective activity in the dry (wet) troposphere, and a southward (northward) shift of the African Easterly Jet (AEJ), a weaker (stronger) Tropical Easterly Jet (TEJ). The analysis of the changes in the regional and global connections of WAM dynamics reveals that in the 4xCO2 simulation the observed relationships with the global SST and the regional dynamics patterns are weaker, while in the 4xCO2 simulation the connections are more robust. Specifically, a strong coupling between the convective precipitation and Sahelian SST is observed, along with a reinforcement of the regional connections with the Saharan heat low, the AEJ and the TEJ.

The above results suggest a competitive action of global SST warming and CO2 increase on the WAM climate variability. The effects on precipitation in CMIP5 models depend on the global SST warming affects Sahelian precipitation by weakening the global Tropical convection, while the CO2 increase results in a strengthening of the regional dynamics features associated to wet conditions in the Sahel. It is argued that the large spread in CMIP5 future rainfall projections may be related to the weight given to SST warming and direct CO2 effect by individual models.

P-3330-30
AMMA-CATCH a hydrological, meteorological and ecological long term observatory on West Africa

S. Galle (1); C. Peugeot (2); M. Gripper (3); I. Bouzou Moussa (4); B. Cappellaere (2); J. Demartey (2); E. Mougin (5); T. Lebel (6)

(1) IJRD, LTHE, 38041 Grenoble Cedex, France; (2) IJRD, Hydrosciences montpellier (hsm), Montpellier, France; (3) Université de Toulouse, Gt, Toulouse, France; (4) Université Abdou Moumouni, Niamey, Niger, Republic of; (5) GET, Umr cirs S563, Toulose, France; (6) IJRD, LTHE, 38041 Grenoble Cedex, France

AMMA-CATCH is a multi-scale observation system dedicated to long-term monitoring of the water cycle, the vegetation dynamics and their interaction with climate and water resources in West Africa. In the context of the global change, long-term observations are required to i) gain understanding in eco-hydrological processes over this highly contrasted region, ii) help their representation in Earth System Models, and iii) detect trends and infer their impacts on water resources and living conditions.

It is made of three meso–scale sites (~ 1°x1°) in Mali, Niger and Benin, extending along the West African eco–climatic gradient. Within this regional window (5° by 9°), each of the three sites comprises a multi-scale set-up which helps documenting the components of the hydrologic budget and the evolutions of the surface conditions over a range of time scales: raingages, piezometers, river discharge stations, soil moisture and temperature profiles, turbulent fluxes measurements, LAI/biomass monitoring.

This observation system has been continuously generating coherent datasets for 10 to 25 years depending on the datasets. It is jointly operated by French and African (Mali, Niger and Benin) research institutions. The data-base is available to the community through the website (www.amma-catch.org). AMMA-CATH participates to several regional or global observation networks, such as FluxNet, CarboAfrica, International Soil Moisture Networks (ISMN) and to calibration/validation campaigns for satellite missions such as SMOS (Europe/France/Spain), MEGHA-TROPIQUES (France/India) or SWAP(NASA). AMMA-CATCH fills a gap over a region, West Africa, where environmental data are largely lacking, and thus, it can usefully contribute to the international networking effort for environmental monitoring and research.

P-3330-31
Preparing for El Nino: a starting point for climate change adaptation for malaria

A. Gemedo (1)

(1) Ethiopian Public Health Institute (EPHI), Bacterial, Parasitic & Zoonotic Diseases Research, Addis Ababa, Ethiopia

Background on impact of El Nino on malaria in Ethiopia

Malaria outbreaks in East Africa and Ethiopia overlapped with El Nino events, which has been documented since the beginning of the 1950s until 2003/2004.

Response of the malaria community based on 2014 early warning

An El Nino was predicted to develop late in 2014 and was expected to last through at least spring 2015. This translated to a period of heightened likelihood that extreme weather conditions can occur with associated malaria outbreaks in East Africa. The International Research Institute for Climate and Society (IRI) issued a Bulletin on “Emerging El Nino conditions: Guidance for the East African Malaria Community following series of consultations.

Difficulties associated with uncertainty of forecast

Forecasting malaria risk remained a series challenge due to focal nature of malaria transmission in Ethiopia.
Analysis of historical events using Ethiopia ENACTS products

The National Meteorology Agency (NMA) and the IRI have been collaborating on improving climate service since 2008. The most prominent of the activities has been the implementation of the ENACTS (Enhancing National Climate Service) initiative, which was first started in Ethiopia. In order to accurately assess the influence of crop yields and malaria epidemics on farmers’ income, we built in order to assess how climatic risk constrains improvement of yields. It impedes the farmers to buy costly inputs while insurance reduces the risk that a drought prevents them from reimbursing the credit. Direct payments also rank high in this respect, because they efficiently mitigate the cash constraint. The amount of subsidies required to obtain a given increase of the value of farm production varies across farm types and subzones in the region, but is relatively reasonable. These results suggest that crop intensification is currently relatively close to becoming a relevant option for farmers and that public policies may favour it by improving the economic environment of farms.

P-3330-32

Policies to favour crop intensification and farm income under climatic risk in West Africa

F. Gérard, (1); F. Affholder (2); A. Ricome, (3); C. Poeydebat (4); B. Muller (5); M. Sall, (6); P. Quirion (7)

(1) IRD, Campus international de recherches ucad/IRD de hann, Niamey (Niger); (2) Cnrs, Cired, nogent sur Marne, France; (3) CiraD, Martinique, le lamentin, France; (4) CiraD, BiOs, Montpellier, France; (5) isra-BaMe, Dakar, Senegal; (6) UMr palOC, lmi pateo, Hydrologie et environnement, saint Martin d'Hères, France; (7) autorité Bassin Niger (ABN), Niamey, Niger, Republic of; (8) CNRM, Toulouse, France; (9) M. Sall, (6) ; P. Quirion (7) ; F. Gérard, (1) ; F. Affholder (2) ; A. Ricome, (3) ; C. Poeydebat (4) ; B. Muller (5) ; M. Sall, (6) ; P. Quirion (7)

In West African countries, agricultural production per capita has decreased over the past half century. With continued population growth and the diminishing availability of marginal arable land, pressure on land is rapidly increasing and there is now a common view that crop yield must be increased in this region, especially as there is a wide gap between actual and potential yields. Although many agricultural options are available, small farmers in the Sahel region, in which a large yield gap exists, are still using traditional agricultural technologies, which in turn impedes the improvement of yields.

In order to assess how climatic risk constrains intensification strategy in West Africa, we built and calibrated a bioeconomic farm simulation model predicting the choice to intensify crops or livestock as depending on the availability of key policies in the economic environment of farms, for typical cases in the groundnut basin of Senegal. These cases include two regions contrasted in terms of rainfall (Sine and Saloum) and in each region two typical farms, representing poor and less poor farmers. The model features uncertainty in weather, crop prices, farmer’s risk aversion, nine cropping systems representing millet, maize and groundnut with various intensification levels, and the inclusion of the interaction between crop and livestock: draught animal power, the feeding of animals with suitable crop products (groundnut hauls, cereal straw) and the production of farm manure. Farmers are constrained by land, labour, cash and credit availability. 180 households were surveyed to build the socio-demographic and economic dataset used by the model, and agronomic data were collected from 206 fields.

These key policies analysed are (i) weather index insurances against drought impact on crop yields, either subsidised or not, (ii) subsidies to short term credit for purchasing farm inputs, and (iii) direct payments to farmers. In our simulations, under the current climate and prices of agricultural products and inputs, all these policies appear favourable to the increase of farmers’ expected utility for typical farms representing the vast majority of farms in the groundnut basin. Apart for insurance, all of them appear also favourable to intensification of crops and livestock activities for those typical farms. Insurance appears favourable to this intensification strategy only for farms located in the northern part of the region studied, where climatic risk is higher. Among the scenarios tested, for most typical farms, combining unsubsidized insurance with subsidized credit appeared as the best use of a given amount of public funds in support of crop intensification: subsidized credit allows the farmers to finance inputs while insurance reduces the risk that a drought prevents them from reimbursing the credit. Direct payments also rank high in this respect, because they efficiently mitigate the cash constraint. The amount of subsidies required to obtain a given increase of the value of farm production varies across farm types and subzones in the region, but is relatively reasonable. It is anticipated that crop intensification is currently relatively close to becoming a relevant option for farmers and that public policies may favour it by improving the economic environment of farms.

P-3330-33

A study of flood intensification in Niamey based on satellite, gauge data and hydrological modeling

M. Gosset (1); C. Casse, (2); C. Peugeot (3); T. Vischel (4); B. Chikhtouni, (5); A. Boone, (6); G. Quantin, (4); V. Pedinotti (6); L. Descroz (7)

(1) Institut de Recherche pour le Développement, Geoscience Environnement Toulouse (GET), Toulouse, France; (2) GET, toulouse, France; (3) IRD, Hydrosciences montpellier (hsm), Montpellier, France; (4) Laboratoire d'étude des transferts en environnement toulouse (Get), toulouse, France; (5) autorité Bassin Niger (ABN), Niamey, Niger, Republic of; (6) CNRM, Toulouse, France; (7) UMR PALOC, Lmi pateo, campus international de recherches ucad/IRD de hann, Dakar–Hann, Senegal

One anticipated impact of climate change is a possible enhancement of the hydrological cycle and an intensification of extreme hydrological events, such as floods. Observing the present and past changes in hydro-systems is helpful to understand the causalities and the respective roles of climate variability and land use changes, in the increase of floods. In many tropical basins, and notably in sub-Saharan Africa there is a deficit of in situ observational data, in these regions satellite data and modeling can help analyzing the hydrological behavior and the recent evolution.

Since the beginning of flows observations, in 1920’s, Niamey (Niger) has suffered drastic hydrological changes. Several studies highlighted the hydrograph modification from one to two floods (around 1970’s). This hydrological change has been attributed to increased runoff, in the increase of floods. In many tropical basins, and notably in sub-Saharan Africa there is a deficit of in situ observational data, in these regions satellite data and modeling can help analyzing the hydrological behavior and the recent evolution.
and lead to severe material losses and several casualties.

Recent studies have raised the issue of a possible increase in extreme rainfall in the Sahel, which may have had an important role in the last extreme floods. This study explores the impact of extreme rainfall events in the Niger flood in Niamey. It focuses on the 125000km² basin between Ansongo and Niamey, corresponding to the drainage area contributing to the first flood. Several long series of rain gauge and satellite rainfall estimations, from 1950 to present, are analyzed and used as input to a hydrological model to analyze the possible role of rainfall in the observed evolution of the flood regime and compare with the effect of land use on the basin. These results should provide a basis to anticipate future changes.

P-3330-34
Towards innovative solutions for monitoring climate changes in observation poor regions: Rain Measurement based on cellular phone networks in Africa

M. Gossset (1); F. Cazenave (2); F. Zougmore (3); A. Doumounia, (3); M. Kacou, (1)
(1) Institut de Recherche pour le Développement. Geosciences Environment Toulouse (GET), Toulouse, France; (2) Laboratoire d'étude des Transferts en Hydrologie et Environnement, Saint Martin d'Hères, France; (3) LAME / Université Ouagadougou, Ouagadougou, Burkina Faso

The observed anthropogenic global warming over the last century is well documented but the effect on rainfall in particular and at small scales is less understood. In future precipitation scenarios is currently subject to large uncertainties and can only be assured if there is a comprehensive understanding of the processes controlling rainfall variability, made possible through reliable rainfall records. In many parts of the Tropics the ground based gauge networks are sparse, often degrading and accessing this data for process studies, climatological analysis or for validating satellite products is sometime difficult. Here a novel approach is presented. It is based on using commercial microwave links from cellular telephone networks to detect and quantify rainfall. Rainfall monitoring based on commercial terrestrial microwave links has been tested for the first time in Burkina Faso, in Sahelian West-Africa. In collaboration with one national cellular phone operator, Telege Faso, the attenuation on a 29 km long microwave link operating at 7 GHz was monitored at 1s time rate for the month of September 2012. The time series of attenuation is transformed into rain rates and compared with rain gauge data. The method is successful in quantifying rainfall: 95% of the rainy days are detected. The correlation at the 5 min time step within each event is 0.8 and the season bias is 5%. The correlation at the 5 min time step within each event is also high. These results demonstrate the potential interest of exploiting national and regional wireless telecommunications networks for monitoring rainfall in the Tropics, where operational rain gauge networks are degrading and the hydro-meteorological risk increasing.

P-3330-35
Less rain but more surface water: paradoxical evolution of ponds and runoff in pastoral Sahel

M. Grippa (1); L. Kergoat (2); L. Gal (2); P. Hiernaux (3); J. Ramarohetra (2); C. Dardel (4); E. Mougin (2); C. Peugeot (5)
(1) Université de Toulouse, Get, Toulouse, France; (2) GET, Umr cnrs 5563, Toulouse, France; (3) retired from CNRS GET, Caumont, France; (4) IRD, Toulouse, France; (5) IRD, Hydrosciences montpellier (hsm), Montpellier, France

The Sahelian region has experienced a dramatic rainfall deficit since the second half of the last century with severe droughts in the early seventies and eighties which had dramatic consequences on the ecosystems and the population living in these areas. In parallel and paradoxically, an increase in runoff in the region has been observed over the same period of time in different areas of the Sahel, particularly in Niger where the increase in areas cleared for cropping was suggested as a possible explanation for this phenomenon. This presentation focuses on the evolution of ponds and surface runoff in pastoral areas in central and northern Sahel, where agricultural activities are very limited. It addresses in particular the Gourma area, in Mali, over which in-situ data on vegetation, meteorological variables and pond and water levels are available via the AMMA-CATCH observatory.

The analysis of different satellite data and aerial photographs revealed a spectacular increase in the size of ponds in the Gourma region over the last 60 years (Gardelle et al. 2010) as well as other similar zones in Mauritania and Niger. A water balance equation, which includes water volume changes derived by in-situ water level coupled to pond’s surfaces, water input by rainfall and water losses by evaporation and infiltration, has been derived for the Agoufou pond. This allowed to quantify changes in the water amount supplying the pond over time, with annual runoff coefficient (estimated as the ratio of water supply over rainfall) going from 0.005 – 0.05 in the 60s–70s, 0.5-1 in the 90s and ranging from 3.5 to 10 in the last ten years.

These results prove that the Sahelian paradox is also taking place in non-cultivated areas. Analysis of land cover changes over the Agoufou and Tin Adjar watersheds indicates that vegetation degradation and soil erosion occurring over the shallow soils that generate most of the runoff ending up in ponds, play an important role on the observed evolution of the hydrological system in these areas.

A first analysis on the capability of general land surface models to represent runoff in the region has been carried out in the framework of the ALMIP2 project (AMMA Land Surface Model Intercomparision exercise, Boone et al. 2009). It was found that the representation of shallow soils has to be taken into better account to correctly represent surface hydrology and runoff in endheric Sahel. More generally, better understanding and modeling the eco-hydrological mechanisms operating in this regions and particularly the co-evolution of vegetation and runoff systems is necessary to correctly reproduce past changes and predict the future evolution of these ponds.

P-3330-36
Temperature in the Sahel: mean climate and multidecadal warming in observations and climate simulations CMIP5

F. Guichard (1); J. Barbier (1); C. Leauthaud (2); L. Kergoat (3); D. Bouniol (1); F. Couvreux (1); B. Diarlo (4); F. Hourtin (4); S. Janicot (5); R. Roehrig (1)
(1) CNRM–GAME (UMR 3589, CNRS and Meteo–France), Toulouse, France; (2) LSCE, CEA, Gif-sur-Yvette, France; (3) GET (UMR CNRS 5563), Toulouse, France; (4) LMD (IPSL, CNRS, UPMC), Paris, France; (5) LOCEAN (CNRS, IPSL, IRD, UPMC), Paris, France

In a companion study (Leauthaud et al., 2015) with observations that the Sahel experienced a strong warming since 1950; it is stronger in Spring, which is already climatologically very hot, and more pronounced in nighttime than daytime temperature. This warming is more pronounced that further South in the tropical Soudanian region and increases with latitude from the Gulf of Guinea to the Sahara. Observations also indicate a decrease of the diurnal temperature range: this warming is more pronounced outside of the rainy monsoon season.

In this study, we address the ability of climate models to simulate these salient observed features. We use outputs from the CMIP5 archive, and in particular amip, control and historical simulations. We also use amip–type cSites output, that allows a more in depth understanding of the physics underlying the simulation of temperature with high–frequency energy budgets (when available). Here, we evaluate the simulation of the annual and diurnal cycles, of the distribution of temperature, and their multi–decadal fluctuations and changes.

The observations used for evaluation include CRU, GHCN and BESt monthly–mean gridded datasets, but also results from several ENSEMBLES and ACCESS projects providing daily minimum and maximum temperature, plus, for some of them, 3–h sampled data. The later are used to compare temperature distributions and distribution shifts in the last decades.

First, it appears that the simulation of the annual cycle of
temperature is very challenging, especially outside of the monsoon season (cf. also Rohrig et al. J. Climate 2013). Simulations often display phase shifts of several weeks to a few months in their extrema (Spring and Autumn maxima and Summer and Winter minima). Biases typically reach a few to several degrees in their monthly–mean values. In numerous models, compensating errors arising from sub–diurnal to seasonal scales are involved in the representation of the annual cycle. In general, differences among models are also found to dominate over differences among scenarios (amip, historical...).

High–frequency observations of the surface meteorology and radiative budget, available over the last decade, point to strong physical couplings between radiative fluxes and thermodynamics, for instance between longwave fluxes, DTR, water vapour, clouds and precipitation. Strong changes are also found in simulations, but they are quantitatively distinct.

The causes and implications of these simulation biases for the study of the Sahelian climate and its future evolution are discussed.

P-3330-37

Characterization of seasons with the wind profiles observed by VHFRadar in West Africa

K. Hilaire (1); E. Houngrinou (1)
(1) University of Abomey–Calavi, Faculty of Science and Technology, Cotonou, Benin

The variability of the West African monsoon had socio–economic and environmental impacts on populations. This variability is closely linked to atmospheric circulation, which also plays a dominant role in the organization of the monsoon. These experimental results provide information on the dynamics of winds through the features of the jets. This study focuses on the interpretation of the statistics of the winds and the identification of the wind systems observed by VHF profiler radar in West Africa. This study will provide a method for detecting and describing the wind systems in the region.

P-3330-38

Description of the agro-climatological characteristics of the rainy season in southwestern Burkina Faso for the 1970-2013 period

B. Ibrahim (1); W. Fonta (1); B. Barry (1); S. Sanfo (1); K. Greenough (1)
(1) West African Science Service Centre on Climate Change and Adaptation (WASCAL), Competence Center, Ouagadougou, Burkina Faso

The rain-fed agricultural system of West Africa is very vulnerable to climate variability. The different drought phases during the last four decades (1970–2010) revealed the weakness of the agricultural system with a high degree of stress on production, and a significant impact on food availability. Many studies have identified the seasonal pattern of the rain events during the rainy season as a key driver of agricultural production failure during these drought phases. In this study, the rainy seasons during the drought phases are characterized by a low annual rainfall amount, a late rainy season onset, and a more frequent long dry spells (>7 days). Unfortunately, the long dry spells are accompanied by high daytime temperature. The intensity and the probability of occurrence of the long dry spells (more than 20 days) are very high in the rainy season are very high in the study area mainly during the sowing and the harvest periods.

While the heat wave impacts on public health have been widely addressed in developed countries especially after the intense event over West Europe during summer 2003, no effort has been made to detect them and evaluate their impact in less developed countries, and especially in West Africa where climate is warmer and adaptation capacities are low. Over West Africa preliminary interviews, climate and epidemiologic analyses show however that this problem is emerging and climate vulnerability is increasing. This study intends to evaluate and should increase in frequency and intensity in the coming decades. However, these climate models display a very high temperature and radiative biases over this region, which might be reduced and generate robust information on the future evolution of heat waves.

Starting from this context, the main objective of ACASIS is to set–up a pre–operational heat wave warning system over West Africa tailored to health risks of the population living in this region. This is a demonstration project focused on Senegal and Burkina where national weather services have already started developing products dedicated to weather/ climate and health relationships, and where several health and demographic observatories have been operating for up to several decades. Based on the analysis of climate and demographic data, the project aims to identify the patterns of the heat waves and their atmospheric patterns will be determined, as well as their evolution over the last decades. Their predictability at short and medium ranges will be evaluated on several scales of multi–year climate variability. On a longer time scale, control simulations and climate scenarios of the CMIP5/AR5 (5th phase of the Coupled Model Intercomparison Project the results of which are synthesised in the IPCC Assessment Report) database will be analysed and the simulated future evolution and associated uncertainty of these events will be evaluated. More precisely the processes at the origin of model radiative biases will be examined and reduced as much as possible. In parallel, epidemiologic studies associated with interviews will be conducted in the health and demographic sites in Senegal and Burkina in order to evaluate the physiologic and social vulnerability of the African population to high temperature extremes. It will allow to define tailored bio–meteorological indicators to be used in the warning system. This will be possible by implementing downscaling to link the synoptic scale of the heat waves to local bio–meteorological indicators, we will set–up a demonstration warning system on a “testbed” platform named MISVA, already implemented as the result of a prior collaboration between Meteo–France, OMP and ANACIM, the meteorological agency of Senegal. Based on the interviews, and with the setting of several workshops with stakeholders and public, the MISVA platform will be able to provide specific recommendations associated to these warnings. An implementation in the Meteo–France operational system at the end of this project or after might be possible.

To carry on this project, a pluri–disciplinary consortium has been set–up gathering climatologists, physical processes specialists, meteorologists, biostatisticians, geographers, socio–economists, epidemiologists, and operational meteorological agencies.
will work through a close collaboration between French and African teams where young African researchers will be highly involved.

P-3330-40

Estimation of the West African Monsoon variability through the analyses of the induced wave parameters

P. Kafando (1); F. Chane-Ming (2); M. Petitdidier (3)
(1) University of Ouagadougou, Department of Physics, Ouagadougou, Burkina Faso; (2) Université de la Réunion, Laboratoire de l’atmosphère et des cyclones, Saint-Denis, France; (3) Université Versailles saint-Quentin; Sorbonne Universités, UPMC Univ. Paris 06 , CNrs/insu, laTMOS-ipsl, Paris, France

Using local (rainfall data) and global satellite observations (atmospheric fields reanalysis, OLR data, satellite-observed brightness temperature data and cloud cluster data), the activity of convective equatorial waves revealed to be strongly coupled with the West African Monsoon (WAM) variability.

A previous study of wave activity in the West African area (Kafando et al., 2008), revealed that the signature of the monsoon is clearly observed on total energy density in the low level atmosphere (19–23 km). The annual cycle and the climatology of wave total energy density showed that peaks of activity match the period of intense convection. In the present study, wave activity in relation with monsoon proxies (convection and precipitations) has been used to analyze the WAM interannual variability using nine years radiosonde observations, Tropical Rainfall Measuring Mission (TRMM) data and Outgoing Longwave Radiation (OLR) data over several West African meteorological stations located in the latitudinal belt 4°N–20°N.

P-3330-41

Impact of climate variability on the water balance of the anthropized Agneby watershed in the southeast of Côte d’Ivoire: application of nTopAmma hydrological model

B. Kamagate (1); N. Dabissi (2); A. Bamba (3); S. Issiaka (4)
(1) Université Nangui Abrogoua, Laboratoire de géosciences et environnement, Abidjan, Ivory Coast; (2) Université Nangui–Abrogoua (Côte d’Ivoire), UFR Sciences et Gestion de l’Environnement (SGE), ABIDJAN, Ivory Coast; (3) Université Nangui Abrogoua, SGE, Abidjan, Ivory Coast; (4) Université Nangui–Abrogoua, UFR, sge, Abidjan, Ivory Coast

Agneby Watershed (8490 km2) is located in the southeast of Côte d’Ivoire. It is subject to a monsoon (1500 mm annual rainfall) with four contrasted climatic seasons. This basin is also subject to strong human impact that contributes to a change in water balance due to intensive agriculture (cocoa, coffee, rubber and food crops).

This work is part of a general framework for understanding the impact of climate variability and agricultural intensification on water resources in the watershed of the Agneby. The main objective of this study is to evaluate by modeling the different terms of the water balance and their evolution over the period 1970–2000. We use a modified version of nTopAmma model developed from observations in the upper basin of Ouémé (wet site AMMA–Catch observatory). The nTopAmma model favours the shallow groundwater efflux as the origin of the flow. The amended taking into account changes in land use and the seasonal cycle of vegetation in the calculation of evapotranspiration can address the impact on the water balance of the plant cover changes.

P-3330-42

Climate impact studies in the Sahel: A word of caution

L. Kergoat (1)
(1) GET, Umr cnrs 5563, Toulouse, France

One can easily understand why climate impact studies are increasingly solicited for regions such as Subsaharan Africa in general and the Sahel in particular. Past climate fluctuations like the multidecadal drought that started in the 70ies had a very strong impact on people, societies, natural resources, and ecosystems. The Sahel drought is the strongest multidecadal drought recorded so far, and this drought combined with a high vulnerability to result in dramatic consequences.

Therefore, it seems meaningful to address the consequences of future climate changes in the Sahel. However, I would argue that a number of limitations and misunderstandings considerably reduce the conclusions one can reach with climate impact studies.

Managers, resources planners, stakeholders, NGOs and scientists in non-climate domain like ecology, hydrology or health, often look for climate projections which have horizons of 20, 30 or 50 years, and in many cases, the regions are local or regional, from the size of a city to one or a couple of countries. Again, the logic behind these scales is rather straightforward: A couple of decades is seen as the proper timescale for local impact studies. For these reason, I would call for cautious in impact studies. Multidecadal variability has to be considered, and its understanding is, in my opinion, a prerequisite to most impact studies. Extensive dialog between communities is needed to clarify this issue as much as possible.

P-3330-43

Improving the incomes of producers on family farms in the context of climate change in Burkina Faso

P. Kinda (1)
(1) Insitut d’Applications et de Vulgarisation en Sciences, Sciences économique des changements climatiques, Ouagadougou, Burkina Faso

Climate change in the context of Burkina Faso results in recurrent pockets of droughts, heat waves, reduction in the number of rain days and a high variability of rainfall. The consequences of this climatic hazards on family farming are inter–alia, the drop of productions and yields. One of the major challenges of the agricultural sector is improving yields and incomes. Our research aims at presenting the initiatives developed in connection with the improvement of yields and incomes of the producers of family agriculture covering more than 90% of farmers in Burkina Faso. Climate information associated with proven practices and the market information system used could inspire other stakeholders of family farming in similar contexts.
**P-3330-44**

**Impact of climate on groundwater recharge in the crystalline basement rocks aquifer of Northern Ghana**

**KV. Koffi (1)**
(1) WASCAL / University of Abomey–Calavi, Abomey–Calavi, Benin

Water is the cornerstone of human life and for all economic developments. West Africa and specifically Ghana are no exception to this reality.

Northern Ghana is characterized by a semi-arid climate, with prolonged dry season (7 months of very few rainfall) leading to the drying up of many rivers and streams. In addition, rainfall is highly variable in space and time. Therefore, surface water is unreliable and insufficient to meet the water demands for socio-economic development in this area. As a result, the area is heavily dependent on groundwater for domestic water supply as well as for dry season irrigation of vegetables (cash crops).

However, aquifers in northern Ghana are dominantly the hard rock type (Crystalline basement rock). This aquifer has no primary porosity and may not be able to sustain the increasing demand on the resource. Further, climate change may worsen the situation as recharge is dependent on rainfall in northern Ghana. Therefore, it is important to understand exactly how climate change will impact on recharge to the groundwater for sustainable development and management of the resource.

Previous groundwater studies in Northern Ghana barely analyzed the impact of Climate change on the recharge to the groundwater. This research is aimed at determining the correlation relationship between groundwater recharge and rainfall and to use the relationships to determine the impacts of changes in climate on the groundwater recharge. The results will inform plans and strategies for sustainable managing groundwater resources in Ghana and the Volta basin.

---

**P-3330-45**

**From Artisans to Entrepreneurs: Understanding the role of small business for sustainable energy access**

**W. Kruger (1) ; R. Aitken, (2)**
(1) University of Cape Town, Energy Research Centre, Cape Town, South Africa, (2) Restio Energy Pty Ltd, Somerset West, South Africa

The «Developing Energy Enterprises Project – East Africa» (DEEP EA) which ran from 2008 to 2013, was funded by the European Union (EU) and the Dutch Ministry of Foreign Affairs (DGIS). The Global Village Energy Partnership – International (GVEP-I) coordinated the partnership programme responsible for implementing the project. DEEP EA aimed to increase clean energy access among the rural and peri-urban poor in East Africa by assisting entrepreneurs to grow their businesses through enterprise training, mentorship and possible linkages to finance. The project was implemented in Kenya, Tanzania and Uganda, and included three principle technologies and services: improved cook stoves (ICS), briquettes and solar PV (solar patterns, solar home systems, and PV-based mobile phone charging). During March 2013, Restio Energy conducted an independent terminal evaluation of DEEP EA. This presentation is aimed at capturing and articulating many of the lessons learned - with the purpose of strengthening majority market climate change mitigation enterprises in the future. DEEP EA provides a number of crucial lessons on the nature of support needed to enable and support seed-led energy access initiatives in Africa. Their project has discovered how to develop people from artisans to entrepreneurs; from someone merely involved in producing a piece of low-tech, low-carbon energy to becoming somebody who takes ownership of the entire business aspect. Throughout the project, there has been an effective non-technical shift in business performance, which (along with the technical abilities) has raised the performance of a significant number of these DEEP EA supported businesses. Overall, the project has developed a deeper and more textured understanding of the challenges of entrepreneurship in East Africa. The small and micro-business model that emerges presents a blend between certain defining features of the formal economy and other features with a distinct “informal economy” nature. The outcome is a blend that is more in-tune with the socio-economic realities of not only the entrepreneurs themselves, but also the market they service. This is where a great deal of support should go in the future, and DEEP EA is to play its indispensable role in meeting the Sustainable Energy for All targets by 2030.

---

**P-3330-46**

**Recent climatological trend of the Saharan Heat Low and its impact in West Africa**

**C. Lavaysse (1) ; C. Flament (2) ; A. Evan (3)**
(1) European Commission / Institute for Environment and Sustainability, Climate risk management unit, Ispra, Italy; (2) LATMOS, Paris, France; (3) Scripps Institution of Oceanography, La Jolla, CA, United States of America

The Saharan Heat Low (SHL) plays a crucial role in the West African Monsoon in spring and summer. The recent trend in SHL activity has been analysed using two sets of numerical weather prediction reanalysis. A local increase during the 90’s has been found in the two sets of temperature. This increase is stronger within the heat low region than the surrounding areas. This change is accompanied by a moderate trend of slow increase of temperature, but we do not observe a change in the filtered signal under 25 days. Despite a large variability of the temporal trends between 15 climate models from the CMIP5 project, the trend is observed using the ensemble mean. Nevertheless, the spatial and temporal evolutions of the HL activities display a large difference between the reanalysis and climate models. The impacts and atmospheric variabilities have been compared in reanalysis and climate models and reveals different behaviours of the climate models to represent the west african monsoon interactions with HL pulsations.

---

**P-3330-47**

**Changes in temperature and precipitation patterns in Benin Republic between 2000 and 2050**

**AE. Lawin (1) ; Pt. Akponikpè (2) ; A. Jalloh (3) ; CG. Nelson (4) ; TS. Thomas (4)**
(1) Faculté des Sciences et Techniques, Laboratoire d’Hydrologie Appliquée, Cotonou, Benin; (2) Faculté d’Agronomie, Environmental soil physics and hydraulics unit. (papa), Parakou, Benin; (3) West and Central African Council for Agricultural Research and Development, Dakar, Senegal; (4) International Food Policy Research Institute, Washington, United States of America

Climate change is considered as a worldwide concern. The consequences include changes in temperature and precipitation patterns, with more and more extreme weather events, and shifting seasons. It will disproportionately affect the poor who depend mainly on agriculture for their livelihoods and have a lower capacity to adapt. Benin republic’s economy is based essentially on agriculture and its population is projected to at least double (to 18 million) or possibly more than triple (to 25 million) by 2050. Food security is therefore a great challenge for policy makers.

This work focused on analyzing climate changes in temperature and precipitation trends between 2000 and 2050 in Benin. Four downscaled climate models (i.e. CNRM–CM3, ECHAM5, CSIRO–MK3 and MIROC3.2 GCMs) and 2 climate scenarios (A1B and B1) were used to assess changes.

We found that all four GCMs show an increase in the normal annual maximum temperature for the whole country, ranging from slight (1°–1.5°C for MIROC 3.2) to substantial (2°–3°C for CSIRO 3.2). The climate models show different outcomes for precipitation levels for the country in 2050. CNRM–CM3 and ECHAM 5 showed increased precipitation, while the two other models (CSIRO Mark 3 and MIROC 3.2) showed areas of precipitation decrease, mainly in the south. These changes in climate may affect in varying ways crop production and food security.
P-3330-48
Observed multidecadal changes in air temperature from 1950 to 2010 in the Sahel
C. Leauthaud (1); F. Guichard (2); L. Kergoat (3); J. Barbier (2)
(1) LSEC, CEA, Gif-sur-Yvette, France; (2) CNRM-GAME (UMR 3589, CNRS and Météo-France), Toulouse, France; (3) GET, UMR cnrs 5563, Toulouse, France

The Sahel experienced in the last decades the strongest climatic regime-accorded changes worldwide, the well-documented changes in precipitation amount and frequency of extreme events, modifications of air temperature stronger than the global increase in mean annual temperature in the past 60 years is evidenced. However, little is known about the changes in the seasonal and diurnal cycles in temperature and the underlying processes. Furthermore, most studies addressing this subject rely on satellite products or gridded datasets and not directly on observational data, thus limiting their temporal depth and accuracy.

The objective of this study was to address this shortcoming by analyzing observational air temperature data obtained from the various synoptic and daily datasets available for the Sahel region (roughly defined here by the box 11°–17°N 15°–25°E) and using additional data (1970–2010) to do so. The whole dataset and the released daily temperature data were collected. Only stations retaining less than 20% missing data were retained for analysis. The global database was completed with additional stations over the Sahel region. Analysis focused more specifically on (i) characterizing the seasonal and daily cycles of daily minimum and maximum temperatures, and (ii) comparing them with available gridded datasets for specific localities.

Preliminary results show that temperature characteristics have indeed evolved, through an increase of mean daily air temperature of over 1°C over all the Sahel. Increases are most important at the onset of the rainy season. The observed decrease in diurnal temperature ranges is mostly explained by strong increases in minimum air temperature. Finally, the evolution of temperature characteristics differed geographically, with stronger variations in the Northern part of the Sahel. It is now important to compare these observational data with meteorological reanalysis and with historical simulations of Global Climate Models. This is undertaken in a companion presentation by Guichard et al. These modifications of daily temperature, diurnal temperature range and maximum and minimum air temperature can have serious consequences on agriculture, but also human health, even the more as increases have occurred in periods of the year during which temperatures are already critically high.

P-3330-49
Innovating low carbon waste management models in developing countries: a case of local community based artisanal entrepreneurship in Sub Saharan Africa countries
J. Li (1); L. Dayan, (2)
(1) Curtin University of Technology, Perth, Australia; (2) University of Paris 1 Panthéon–Sorbonne, APREIS, Paris, France

The prospect of global economic growth in the next decades will depend on the performance of emerging and developing economies given their rapid population growth and accelerated urbanisation and industrialisation. Growth in emerging markets will not sustain without the inseparable concern for ecological sustainability of their economies and the global environmental challenges such as climate change. The global sustainability targets can only be achieved when actions are taken at both global and local levels. It entails decoupling the global economy of pollution, shaping autonomous and endogenous local development models, organizing productive social inclusion while enabling decentralized governance of a multipolar global economy at the local level, driven by local solidarity initiatives and culture-specific entrepreneurship in developing countries and not directly on observational observational data, thus limiting their temporal depth and accuracy.

The widespread practice of dumping waste into water bodies and scattered dumps prompted by fast-growing urbanization contribute to aggravate the problem. In effect, investments from FDI and aid programmes led by international institutions such as UNK and UNEP, World Bank, which have indeed brought capitals and technologies necessary for the socio-economic development programmes in SSA countries. It is not yet clear how these parachuted aids and investments are accommodated locally and how they impact traditional artisanals in waste treatment from the perspective of poverty reduction and local governance for climate change mitigation and adaptation. It would be inappropriate to transplant directly the top-down waste management model developed in industrialised countries to SSA without adaptation to local community-based solidarity culture and inclusion of bottom-up entrepreneurship innovations, particularly in the domain of utilisation of agricultural residues for generating renewable energy. This study attempts to answer a key climate policy question: how can low-income SSA countries deal with a climate-fried environment? The paper presents a bottom-up and circular economy growth model incorporating bottom-up entrepreneurship innovations? The model takes into account traditional artisanal know-how and communal solidarity as well as sustainability ethics and well-being of the poorest sectors which is pertaining to Africa in the context of growing urbanization and socioeconomic transition. Our study focuses on several low-income countries in SSA: namely Cameroon, Ivory Coast, Burkina Faso, Guinea, Senegal, Niger and Ghana. To render our research results replicable to a broader development perspective, we draw lessons from the experiences in the projects implemented by APREIS in Burkina Faso and Cameroon over the past years and also from some Latin American countries such as Brazil and Argentina in particular where waste management is characterised by bottom-up civil organization model with limited state intervention. Community economy experiences learnt from our fieldwork suggest that pro-development policy encouraging inclusive innovations in climate friendly waste management entrepreneurship has to incorporate four building blocks: economic, social, environmental and cultural dimensions within a coherent climate governance framework in SSA countries.

P-3330-50
Multi-Agent System for simulating the change pattern of agricultural land-use under changing climate in the semi-arid region of Ghana
A. M. Louaili (1); G. Villamar (2); MA. Emmanuel (3); KB. Nicholas (4)
(1) Kwame Nkrumah University of Science and Technology (KNUST), Civil Engineering, Kumasi, Ghana; (2) Centre for Development Research, Bonn, Germany; (3) University of Ghana, Legon, Development research, Land Use Dynamic simulator (sKY-lUDas) project, Accra, Ghana; (4) Kwame Nkrumah University of Science and Technology (KNUST), Agricultural engineering, Kumasi, Ghana

One of the operationalised tools of human–environment system (HES) approach is Multi-Agent System (MAS) which has been used in a number of areas to study the dynamics and management of human–environment systems, especially when facing unexpected disturbance. Therefore, increasing studies are interested in using MAS approach for the understanding of agricultural adaptation to environmental change. However, when it comes to the use of MAS for the operationalization of adaptation decision making in agricultural land–use based on the implications of climate variability, only very few studies empirically operationalize the concept. This research, Land Use Dynamic Simulator (SKY–LUDAS as referred to the communities where it was implemented: Sirigu-Sumbungri–Kandiga–Yuwa) framework was applied by implementing decision-making in some sub models. Therefore, three scenarios have been designed and tested: baseline (Baseline), perception of climate change (PCC) and No perception of climate change (NO-PCC). Simulation results of SKY–LUDAS suggested that the
land-use behaviour in the study area reflects a tendency of subsistence farming. In terms of farm-households’ livelihood strategy, especially the structure of the farm income, there was a growing contribution of rice and groundnuts. Accordingly, SKY-LUDAS has revealed a general trend among land-use types from traditional cereals farming to the cultivation of groundnuts and rice. As a result, this study has a merit of contributing to answer the critical question on whether certain adaptation decisions are required after the observed change. Consequently, one might expect farmers in the study area have adapted their land-use to climate change based on their income source and gradual change in the cultivated land-use in the purpose of being less dependent on the vulnerable farming systems.

**P-3330-51**

**A Bayesian Trend analysis of annual maximum stream flows of the Oti River Basin (West Africa)**

B. H. Maleki (1)

(1) WASCAL GRP – Climate Change and Water Resources, University of Abomey-Calavi, Benin, Benin

Non-stationary analysis of hydrological extremes is crucial for characterizing hydrological phenomena, planning and management of hydrological and water resources systems. Moreover, Bayesian analysis appears to be a comprehensive framework for deriving complex statistical models and implementing uncertainties into induction problems. For this study which is conducted in the Oti River Basin, West Africa (27°5,859 km²), a set of discharge data from two gauging stations in Benin (upstream at Porga) and Ghana (downstream at Saboba) were obtained from the national hydrological services. These records were quality checked and preprocessed in order to derive long term annual maximum stream flows (AMSF) time series between 1952 and 2008. The Generalized Extreme Value (GEV) distribution was fitted to AMSF under stationary and non-stationary conditions. The non-stationary component introduced here is the variation of AMSF over time. To this end a time covariate was introduced in the location parameter of GEV distribution using a Bayesian approach. The results showed better non-stationary fitting for the upstream site (Porga) which exhibits significant decreasing trend in AMSF. The reservoir between the two gauging stations strongly controls the flows at the downstream gauging station which in turn affected the detection of no significant trend in AMSF while annual maximum rainfall are changing over the basin. The estimated return levels under non-stationary conditions showed a decreasing trend over time. This could be the base for further wind resource research within the basin. However, further investigations are required to understand the impact of the reservoir on the downstream discharge in general, but also on extremes and the occurrence of floods.

**P-3330-52**

**Impact of deforestation on surface water and energy feedbacks in sudanian region of West Africa**

O. Mamadou (1); S. Galle (2); J.M. Cohard (3); C. Peugeot (4); J. Seghieri (5); B. Kounouhewa (6); O. Mamadou (7)

(1) Université d’Abomey-Calavi, Laboratoire de physique du rayonnement, Abomey-Calavi, Benin; (2) IRD; LGHE; 33414 Grenoble Cedex, France; (3) Université Grenoble Alpes, LTHI, Grenoble, France; (4) IRD; Hydrosiences montpellier (Hsm), Montpellier, France; (5) I.R.D., DCDS- Département Environnement et Ressources, Montpellier; (6) Université d’Abomey-Calavi, Laboratoire de physique du rayonnement, Abomey-Calavi, Benin; (7) Université de Liège Gembloux Agro-Bio-Tech, Exchanges ecosystèmes – atmosphère, Gembloux, Belgium

In West Africa, surface atmosphere exchanges have been found to impact both regional and local features of the Monsoon. At local scale the spatial patterns of evaporative fraction can drive the trajectories of mesoscale convective systems. Within Sudanian climate, ~80% of the precipitation reaches the atmosphere through evapotranspiration. However, this amount and its seasonal dynamic may vary with the vegetation cover. Consequently, one might expect that any land use or climate changes could lead to the modification of the surface water and energy feedbacks, and, thus both the atmosphere and the regional water cycle. Finally, the sudanian region of West Africa is submitted to a 3% demographical increase per year, which induces a drastic expansion of crops areas. This study aims at quantifying the changes in evapotranspiration and sensible heat flux regimes caused by such a land use change under sudanian climate.

**P-3330-53**

**Impact of Climate, Agriculture and Vegetation in the Sahel in the recent past : the CAVIARS Project**

B. Marticorena (1); CT. The (2)

(1) LISA, CNRS-UPE–UPD–IPSL, Créteil, France; (2) GET; CERED; Université Grenoble alpes, Grenoble Cedex, France; (3) Université Grenoble alpes, Grenoble, France; (4) Université d’abomey-Calavi, laboratoire de physique environnement et ressources, Montpellier cedex 5, France; (5) lisa, Cnrs-UpeC-UpD-ipsl, Créteil, France; (6) Get; Cered; Université Grenoble alpes, Grenoble Cedex, France; (7) Université de Liège Gembloux agro-Bio-tech, Gembloux, Belgium.

The semi-arid regions of the Earth are particularly vulnerable to climate changes, which are expected to significantly affect earth’s systems. The Sahelian region of West Africa has experienced contrasted climatic conditions during the last decades, with severe drought in the 70’s and 80’s and a relative re-greening in the recent years. Over the same period, changes in land use have occurred with an increase of the cultivated surfaces leading to a decrease of falls and rangelands. As a result, a significant proportion of the land is bare or sparsely vegetated, and thus is not able to modulate rainfall, temperature, runoff and wind erosion. In this region, wind erosion tends to decrease the productive capacity of the soils whose fertility is already very low. In addition, the impact of wind erosion is expected to increase significantly in the near future (1) in relation with the expected changes in climate (in particular the modifications of precipitation and surface wind) and (2) in response to the increasing land use due to population increase and the related food needs.

The aims of the CAVIARS project (Climate, Agriculture and Vegetation: Impacts on Aeolian Erosion in the Sahel) are to develop an integrated modeling tool to describe the evolution of wind erosion in the Sahel in connection with climatic and land use changes, to validate this tool in a current period and in the near future using the numerous data sets acquired in recent years over West Africa, and to test its ability to reproduce specific events (such as the drought in the Sahel) of the recent past (about the 70-80 years). This study is based on a modeling approach of this recent past (hindcasts) that is justified by the need to ensure the robustness of the simulations with different forcings prior to any simulation of future scenarios.

The proposed strategy is (1) to develop or optimize reliable modeling tools for quantifying the various terms (lateral use, changes in climate, changes in the intensity of wind erosion) to synthesize quality-checked observations, that can be used as direct or indirect indicators of wind erosion (precipitation time series, changes in vegetation coverage, deep rooting systems, wind load,...) (2) to implement a validation strategy based on the quantification of wind erosion both locally, measured on grazed and cultivated plots, and at the regional and continental scales.
P-3330-54
Using long-term rainfall and streamflow trends to inform local level agricultural water management in Benin
M. Masiyandima (1); C. Mufwaya, (1)
(1) AfricaRice, Sustainable productivity enhancement, Cotonou, Benin

Due to lack of irrigation and water storage facilities rice production is mostly practiced under rainfall conditions across most of Benin. Farmers use temporary water control structures to divert water from streams to rice fields in valley bottoms. This type of production system is dependent on rainfall and streamflow. It is vulnerable to natural variability of rainfall and streamflow. Analysis of rainfall and streamflow observed in the Ouémé River basin between 1951 and 2012 was carried out to understand rainfall and streamflow trends at local level to identify relevant climate indicators and data that best serve the needs of farmers for water management at local level as a way to improve water management and productivity under a changing climate. The Mann–Kendall test was used for the analysis. Significant rainfall trend was confirmed at 3 of the 19 rainfall stations in the basin. The 3 stations showed increasing rainfall at 95% confidence level. An increasing trend was evident at 13 stations but not significant at 95% confidence level while a decreasing trend was evident at 3 stations. Decreasing streamflow trend (95% confidence) was confirmed at 3 of the 13 streamflow gauging stations in the basin. Further analysis of streamflow for the non-perennial rivers in the basin showed increasing number of days with zero flow at 2 of 8 streamflow gauging stations and decreasing number of days with zero flow at 1 station (95% confidence). Long term trend of monthly rainfall for June, July, August and September (the rice growing season) projected trends to inform local level management at local level. This research highlights the relevance of considering indicators that may be relevant for local level water management in support of rainfall agricultural production in the Ouémé River basin in Benin.

P-3330-55
Assessment of climate change impact on water resources in the senegal river basin
ML. Mbaye (1); A. Haensler (2); S. Hagemann (3); AT. Gaye 0
(1) Université Cheikh Anta Diop, Ecole Superieure Polytechnique, Fann–Dakar, Senegal; (2) Climate Service Center Hamburg, Germany; (3) Max Planck Institute for Meteorology, Hamburg, Germany

In this study we assess the impact of climate change on water resources by using uncorrected and bias corrected data of the regional climate model REMO simulations over the Senegal River Basin (SRB). Both simulations were used as input of the Max Planck Institute for Meteorology – Hydrological Model (MPI–HM) over the Upper Senegal Basin (USB).

Applying the bias correction simulations of present day climate (1971–2000) substantially improved for both temporal and spatial variations of the analyzed climate parameters (precipitation, temperature) when compared to observations and independent station data. Additionally, the bias corrected input give better representation of the mean river flow regimes and the 10th (low) and 90th (high) flows at the outlet of the USB.

For the future, the regional climate model projections for precipitation show a general decrease by the end of 21st century (2071–2100) for both scenarios (RCP4.5 and RCP8.5). The relationship between the two areas and datasets in the majority of the basin, except the Guinean highlands where slight increase is found. In case of the potential changes of the maximum number of dry days and wet days, the northern basin is likely to face the most pronounced increase of dry days and decrease of wet days, although slight increase of heavy rainfall is found with similar spatial patterns in both data. Higher decadal variability of the maximum 5-day precipitation with the uncorrected in RCP8.5 is projected, while uncorrected and bias corrected data depict similar temporal variability for decades to centuries. Furthermore, a general temperature increase is dependent on rainfall and streamflow. It is vulnerable to natural variability of rainfall and streamflow. Analysis of rainfall and streamflow observed in the Ouémé River basin between 1951 and 2012 was carried out to understand rainfall and streamflow trends at local level to identify relevant climate indicators and data that best serve the needs of farmers for water management at local level as a way to improve water management and productivity under a changing climate. The Mann–Kendall test was used for the analysis. Significant rainfall trend was confirmed at 3 of the 19 rainfall stations in the basin. The 3 stations showed increasing rainfall at 95% confidence level. An increasing trend was evident at 13 stations but not significant at 95% confidence level while a decreasing trend was evident at 3 stations. Decreasing streamflow trend (95% confidence) was confirmed at 3 of the 13 streamflow gauging stations in the basin. Further analysis of streamflow for the non-perennial rivers in the basin showed increasing number of days with zero flow at 2 of 8 streamflow gauging stations and decreasing number of days with zero flow at 1 station (95% confidence). Long term trend of monthly rainfall for June, July, August and September (the rice growing season) projected trends to inform local level management at local level. This research highlights the relevance of considering indicators that may be relevant for local level water management in support of rainfall agricultural production in the Ouémé River basin in Benin.

P-3330-56
The main projections of the West African monsoon: mean climate, seasonal cycle, extreme rainfall events
PA. Monerie (1); E. Sanchez-Gomez (1); J. Boé (1)
(1) CERFACS, Toulouse, France

The main responses of the climate change effect on the West African Monsoon is evaluated in terms of mean climate and intense rainfall events with CMIP5 models under the rcp8.5 emission scenario. We examine the projections and how they are related to the mean biases of the historical model simulations. The projections range from an increase to a decrease of rainfall amounts, exhibiting a large spread. These differences are due to radiative forcing ranging from 4 to 6°C in the Saharan desert and to feeding (export) of moisture at low–level (mid-level). A majority of models exhibits a decrease (increase) of rainfall over the western (central) Sahel along with more subsidence (air ascent) and a southward location of the AEJ (more moisture flux convergence). The extreme indices change exhibit a more extreme Sahelian climate, but the results remain strongly model–dependant. This study draw up a catalogue of the model projections in order to allow a selection of models for impact studies.

P-3330-57
The impacts of environmental variability and model uncertainty in disease prediction
A. Morse (1); A. Jones, (1); C. Caminade (1); J. Leedale, (1); D. Macleod, (2)
(1) University of Liverpool, Geography and Planning, Liverpool, United Kingdom; (2) University of Oxford, Physics, Oxford, United Kingdom

Modelling vector–borne diseases using dynamical models driven by climate and environmental variables is a complex task. The models require both accurate predictions of the seasonally varying values of environmental drivers and their correct variability across a range of time scales from days to decades. Whereas, the model’s internal structures and the parameter settings for key processes have to be adjusted for use, the pace and quantity of model runs required in large collaborative projects make it difficult to find time and resource to allow detailed in depth diagnosis. Development of model driven methods and visualisation needs to be supported with the ever increasing loading of climate model runs that are being undertaken by disease modelling groups.

In this paper we discuss two models the established Liverpool Malaria Model (LMM) and the recently developed Liverpool Rift Valley fever model (LRVF). Using the LMM we explore the relationship between seasonal average climate and malaria risk, which remains largely unquantified.
We also investigate key uncertainties in the malaria module by mimicking variability in parts of the model formulation. Results are visualized as location specific impact surfaces: easily integrated with ensemble seasonal climate forecasts. Using the LRVF, which is based on both biophysical and complex models, having two dynamic vector models and a dynamic age stratified host model. One main task in its development was parameterising the two different behaviours of the two vectors correctly in the model. Culex spp. were the only model vector that, in the model, and only show significant spikes in population dynamics and EIR following flooding and a sizable Culex spp. population. The Culex spp. were included in the model with a substantial number of infectious mosquitoes for the simulation model. These host infections came from Aedes spp. mosquitoes whose relationship with rainfall is more complex and gain infection through vertical transmission.

P-3330-58

How farmers permanently adapt to climate evolution by testing new options and caring for food security: case of long-cycle sanyo millet comeback in Serer area in Senegal

B. Muller (1); L. Richard (2); P. Kouakou (3); S. Arame (4)

(1) CIRAD, Bios urm agap, Montpellier, France; (2) IRD, Umr 151 urd/amu, Marseilles, France; (3) ISRA–CERAAS, Thiès, Senegal; (4) UCAD, Département de géographie, Dakar, Senegal

During the last decade, Serer farmers of the Sine region in the central and western part of Senegal have started to grow sanyo (Pennisetum glaucum) millet. It is a long-cycle (110–140 days) and photoperiodic traditional variety that had disappeared for 30 years from this region due to the rainfall decrease which has affected the Sahelian and Sudano-Sahelian zones starting from 1970, leaving only the short-cycle (90 days) souma millet in the fields. We made the assumption that the reintroduction of the sanyo millet could be an agronomic “marker” of the increase in rainfall observed in Senegal since the mid-1990s (Salack and al., 2011) attesting to the capacity of farmers to adapt to the evolution of their environment. We wanted to check, however, whether this necessary climatic opportunity was sufficient to explain farmers' choices.

We investigated how important was the sanyo comeback in local farming systems, its biophysical, economic, social and cultural drivers. We carried out (a) simulations of souma and sanyo annual development during the 1950–2013 period using the SahelCG models with farmers’ crop development with farmers; (b) a large survey by questionnaire on farming systems among 1,061 farms in the 30 villages of the IRD’s study area, conducted in Senegal since the mid-1990s (Salack and al., 2011) attesting to the capacity of farmers to adapt to the evolution of their environment. We wanted to check, however, whether this necessary climatic opportunity was sufficient to explain farmers' choices.

We investigated how important the sanyo comeback in local farming systems was. We also included the biophysical, economical, social and cultural drivers. We carried out (a) simulations of sanyo and souna annual development during the 1950–2013 period using the SahelCG models with farmers’ crop development with farmers; (b) a large survey by questionnaire on farming systems among 1,061 farms in the 30 villages of the IRD’s study area, conducted in Senegal since the mid-1990s (Salack and al., 2011) attesting to the capacity of farmers to adapt to the evolution of their environment. We wanted to check, however, whether this necessary climatic opportunity was sufficient to explain farmers' choices.

Crop model simulations confirmed that sanyo reappearance is due to the recent rainfall improvement which now allows getting again grains with this variety with a significant increase in production of millet with souna. But simulations also show that sanyo yields remain very risky due to the rainfall interannual variability whereas souma yields are higher and surer. They also show that sanyo has a higher biomass (stems and straw). Farmers comments and surveys data analysis complement and confirm the results of the simulations. First, peasants report that they prefer the taste of sanyo and above all the quality of its stems rather than those of souna. Moreover farmers point out that they would plant fields dedicated to sanyo only if they were sure to produce enough souma. This is why sanyo is mainly cropped in association with souma, in an average proportion of 1 line of sanyo for 4–5 lines of souma. Moreover in the Serer area, the majority of farmers are the most cautious in sanyo if they had other opportunities, particularly if they provide cash. Thus, despite its spectacular diffusion, sanyo cover very little surfaces: in the zone of Niakhar it was present in 2013 on 2.8% of the cropped areas and on 7.3% of millet areas.

Sanyo reappearance and its important and rapid diffusion is clearly an agronomic “marker” of the recent climate evolution (rainfall increase) observed in Senegal. It attests to the adaptive capacity of farmers to quickly and autonomously adapt to the evolution of their environment by permanently looking and trying new options, but underlines how cautious they are to not endanger their food security, and confirms that a climatic opportunity is not sufficient to account for farmers’ choices. Comparisons can be made between the same area and developments of maize and rainfed rice areas in the southern areas of Senegal, which have been enabled by the rainfall evolution but benefit of solid economical drivers.

P-3330-59

Economic futures of African family farms in the face of climate change: addressing three big questions through integrated assessment with a Tanzanian case

K. Mutabazi (1)

(1) Sokoine University of Agriculture, Agricultural Economics and Agribusiness, Morogoro, Tanzania, United Republic of

Family farms have sustained the livelihood and development of most Sub-Saharan African countries and will continue to do so for a foreseeable future. Much of the development of such economies has been undertaken in the face of climate change. Where such attempts have been made, the assessments overall fail short of an integrated approach that utilizes recent advances of interfaced biophysical and economic modeling. Based on a sample of 168 family farms in the semi-arid and sub-humid farming systems of Wami-Ruvi Basin in Tanzania, the paper applies an integrated climate change assessment to address the following three big questions: How the African family farmers will be impacted by climate change if they continue with business as usual? What will be the impacts with foreseen development pathways without adaptation? What will be the impacts with foreseen development pathways with adaptation?

P-3330-60

Trends in daily extreme precipitation and temperature indices over Ghana from 1980 to 2011

F. Nkrumah (1); NAB. Klutse (2)

(1) University of Cape Coast, Physics, Cape Coast, Ghana; (2) Ghana Space Science and Technology Institute, Remote Sensing, GIS, Climate, Accra, Ghana

In this study, the spatial and temporal patterns of the variabilities in the indices of precipitation extremes, on the basis of daily data and its association with climate change at ten weather stations in Ghana over the period 1980–2011 were analyzed. Daily temperature (maximum and minimum) and precipitation data over the period of 1980 to 2011 were used. Data were quality controlled and processed into indices of climate extremes, and the indices were calculated using RCLimDex which is based on R software and is developed and maintained by the Climate Research Branch of the Meteorological Service of Canada. From 1980 to 2011 hot days and nights have increased, leading to a decrease in cold days and nights. Except simple daily intensity (sDI) index station, other precipitation indices

616
do not illustrate statistically significant trends across the whole region. The precipitation indices show a general increasing trend in annual rainfall (PRCPTOT), heavy precipitation days (R10mm) and very heavy precipitation days (R20mm) with an increasing trend also in the simple rainfall. However, the results at other precipitation indices indicate an unstable trend in the intensity of rainfall. In spite of the results of the precipitation indices it is noticed that more intense rainfall is observed in the short period of January, February and March, which have increased markedly in the period 1971–2000. For example, in February, the number of heavy precipitation days increased from 34.7 to 52.6 mm, while the very heavy precipitation days increased from 5.7 to 11.5 mm. This indicates that the intensity of rainfall is increasing in the Okpara River basin, which has led to a degradation of water resources in the basin.

1.5 and 2°C in the basin by 2050. The fall in rainfall would be between 11 and 30%. As for river flow, during the same period, the decline will increase up to 30% by 2025 and beyond 40% by 2050. If this trend is not reversed, we will be through the terminal stage of degrading water availability in the basin.

In this increasingly climate dryness context, potential reduction of surface water resources disrupts the performance of ecological and socioeconomic systems. Facing this situation, efforts to mobilize surface water for agricultural purposes are the main measures for adapting to climate impact hazards in the basin. These efforts should be continued and backed up for a sustainable economic production.

**P-3330-61**

Reviving a 13th Century Craft to Enhance Community-Based Adaptation through Ecosystems and Farm-lands Resilience enhancement in Uganda

D. Nkwanga (1)
(1) Nature Palace Foundation, Programs, Kampala, Uganda

Bark-cloth making is a 13th Century craftsmanship steeped in ancient culture and tradition where it played significant cultural, financial, social and conservation roles. Uganda’s bark-cloth is internationally acclaimed as a masterpiece of the world’s intangible heritage and indigenous textile production craft, is produced from Ficus natalensis. The F. natalensis trees are cultivated on the farm in a agro-forestry system that is zoned with crops. The bark of the tree is harvested, without harming the tree, to make an environmentally-friendly, renewable material. Where the trees have been cultivated it has been found a unique fabric produced by bark-cloth and others are able to withstand dry spells better than where it is not cultivated. Beyond this, F. natalensis branches are harvested to provide a sustainable supply of firewood making households energy-secure and reducing deforestation. By combining the benefits of deforestation – cooking energy being one of the major causes of deforestation and environmental degradation, logging of trees for providing fodder for domestic animals; and, the sale of bark-cloth provides a passive income that is always accessed by households even if the weather conditions are not favorable for seasonal crops. The presentation discusses the potential of bark-cloth making as a stimulus to long-term community-based adaptation.

**P-3330-62**

Climate change and surface water resource mobilization for agricultural purposes in the okpara basin (west africa)

R. Ogouwale (1)
(1) Université d’Abomey–Calavi, Laboratoire Pierre PAGNEY, ABOMÉY–CALAVI, France

This research aims at evaluating the ongoing impacts of climate change on water resources availability in the Okpara basin. It seeks to identify water resources vulnerability in the basin in regard to the ongoing climate changes. These changes are characterized by variability in climate indicators.

To identify current climate change impacts, climate data of the normal (1941–1970) and (1971–2000) are assessed and compared. The rainfall averages have been used to determine differences (gaps) between the two above-mentioned normal. The data generated at different levels have been translated into relative values. As for temperatures, warming indicators are identified on the basis of calculation of the differences (° C) between the said normal (1941–1970 and 1971–2000). Besides, considering the evolution of climate parameters on the target period, 1971–2000, their future trend has been estimated.

Comparative analysis of the rainfall data between normal rainfall 1971–2000 and 1941–1970, shows overall that rainfall has decreased by 16 and 28% in the Okpara basin. During this very period of time, temperatures have increased overall by +1°C in the basin.

This has led to a degradation of water resources in the basin, which has resulted in the Okpara River’s flows downfall. In fact, analysis of the hydrological flow rate over the period 1965–2000 shows an overall downward trend of about 20–25% during July, August, September and October, which consequently reduces water resources availability in the basin.

On the basis of projections and events considering the period 1971–2000, temperatures will be rising between 1.5 and 2°C in the basin. The fall in rainfall would be between 11 and 30%. As for river flow, during the same period, the decline will increase up to 30% by 2025 and beyond 40% by 2050. If this trend is not reversed, we will be through the terminal stage of degrading water availability in the basin.

In this increasingly climate dryness context, potential reduction of surface water resources disrupts the performance of ecological and socioeconomic systems. Facing this situation, efforts to mobilize surface water for agricultural purposes are the main measures for adapting to climate impact hazards in the basin. These efforts should be continued and backed up for a sustainable economic production.

**P-3330-63**

Challenges of climate change in Southeastern, Nigeria: Sustainable containment measures

E. Okoyeh (Okoro) (1)
(1) Nnamdi Azikwe University Awka, Nigeria, Dept. of Geological Sciences, Awka, Anambra, Nigeria, Federal Republic of Nigeria

Climate change, a global phenomenon has recorded great significant in sub-Saharan Africa and Nigeria in particular. The total environment of land, water and air are under the severe threat of climate change challenges (CCC). The ecological hazards of gully erosion and landslide ravaging Southeastern, Nigeria though geogenic/anthropogenic in origin have been exacerbated by increasing impacts of climate change. The well established variation in the onset and cessation of rainfall and temperature have significant implication on water availability, water quality, ecological hazards, vegetation cover, food security and public health. The torrential rainfall with attendant huge runoff results in flooding. The impacts of climate change induced flooding is significant in rural, semi urban and urban areas of southeastern, Nigeria. Loss of farmland and water sources with impact on food and water security respectively has been recorded. Standard of living and sustainable socioeconomic developments are hindered due to climate change challenges (CCC) in Southeastern, Nigeria. Outbreak of water borne diseases especially in the riverine areas is a recurrent trend affecting poverty alleviation and capacity building. Siltation of rivers, lakes and streams is commonplace exacerbating water scarcity and sustainable development. Heavy rainfall that initiates the development of new gully erosion and landslide ravaging and widening of existing ones is a consequence of climate change challenge (CCC) in the area. Over 750 active gully erosion and landslide sites have been identified in Southeastern, Nigeria with depth ranging from 2 m to > 300 m and length from 25 m to 2.9 km. Removal of sediments from gully and landslide sites and deposition of same in surface water sources has resulted in the siltation of most rivers and lakes in the area. This is complimented by the excessive heat and temperature of above 400C during the dry season to cause total loss of some surface water bodies. The impact of desert encroachment also abounds with the rate of southwards advancement of desert increasing seasonally. The degradation of the rainforest vegetation to savanna grassland with remnant of rainforest vegetation only around water courses has generated serious concern to all stakeholders in recent time. The rainforest vegetation of southeastern, Nigeria has been severely degraded exposing the arable lands to the scouring effects of climate change. These climate change challenges (CCC) disproportionately affect women and children in the developing economies such as Southeastern, Nigeria. There is need for the creation of awareness on the adverse effects of climate change on the environment in terms of water scarcity, gully development, vegetation degradation and food security. Tree planting campaign of planting two trees at the riverbed of one should be promoted and given the wide publicity it deserves. Laws prohibiting illegal tree cutting and building along flood plains should be constituted with the political will to punish defaulters. Establishment of research centers for researching on climate change related issues is also recommended.
Use of the CORDEX simulations to with ORCHIDEE crop to assess the impact of +2/4 K climate change on crop yields in Subsaharan Africa

B. Parkes (1); B. Sultan (2); P. Clais (3)
(1) UPMC, LOCEAN, Paris, France; (2) IRD, LOCEAN, Paris, France; (3) IPEL, Lsce, Gif-sur-Yvette, France

The population of Subsaharan Africa is projected to increase during the 21st century. This population increase needs to be matched with an increase in the amount of food available.

The IPCC AR5 used the CMIP5 models to assess future climate impacts on a regional and global scales. Alongside the development of AR5 recent publications have changed our understanding with respect to passing certain climate thresholds. The +2/4/6 K global temperature changes are examples of these thresholds. The Representative Concentration Pathways (RCPs) used in AR5 were simulated using different inputs and models and therefore reach temperature thresholds at different times. Here we present the projected change in crop yields in Subsaharan Africa for global average temperature changes of +2/4 K.

In tropical regions the ability of Global Climate Models (GCMs) to reproduce realistic weather patterns is known to be poor, this is largely due to the low resolution of climate models being unable to simulate the weather conditions accurately. To counteract the low resolution issues, the Coordinated Regional Downscaling Climate Downscaling Experiment (CORDEX) used several Regional Climate Models (RCMs) to focus on specific geographical regions, including Africa, South East Asia and Europe. The higher resolution RCMs are better at simulating accurate weather and can be bias corrected to remove any large inconsistencies. Models which represent the range of the CORDEX simulations have been used to drive the ORCHIDEE-Crop model. The ORCHIDEE-Crop model is the crop specific version of the ORCHIDEE land surface model. The crop specific version has been tuned to produce accurate yields with various crops including maize, wheat and rice.

In this work we investigate how maize yields will change in Subsaharan Africa at +2/4 K using data from the CORDEX experiments. The changes in yields and the responses to different stresses will be used to assess how the future climate will affect the populations in Subsaharan Africa.

Observed long-term land cover vs climate impacts on the West African hydrological cycle: lessons for the future?

C. Peugeot (1); S. Galle (2); M. Grippa (3); I. Bouzou Moussa (4); B. Cappelare (5); J. Demarty (1); E. Mougin (6); L. Descroix (7); T. Lebel (8); C. Dardel (6); G. Favreau (1); P. Hiernaux (9); L. Kergoat (6); Y. Nazoumou (10); J. P. Vandervaere (11); L. Séguis (1); L. Leroux (12); M. Malam Abdou (13); V. Orekan (14); J. Oszwald (15)
(1) IRD, Hydromet, Montpellier, France; (2) IRD, IRTHE, 38041 Grenoble Cedex, France; (3) Université de Toulouse, Get, Toulouse, France; (4) Abdou Moumouni University, Niamey, Niger, Republic of; (5) IRD, Hydrosciences Montpellier, Montpellier, France; (6) GET, UMR 5563, Toulouse, France; (7) UMR PALOC, Lmi pateau, campus international de recherches ucad/ird de hann, Dakar–Hann, Senegal; (8) IRD, IRTHE, 38041 Grenoble Cedex, France; (9) IRSN, CEA, Cadus, France; (10) Université Abdou Moumouni, Niamey, Niger, Republic of; (11) Université de Grenoble, Grenoble, France; (12) CIRAD, Umr tetsis, Montpellier, France; (13) Université de Zinder, Dept of geography, Zinder, Niger, Republic of; (14) Université d’Abomey Calavi, Labee, Cotonou, Benin; (15) Université Rennes–2, Umr letg, Rennes, France

West Africa has experienced a long lasting, severe drought as from 1970, which seems to be attenuating since 2000. It has induced major changes in living conditions and resources over the region. In the same period, marked changes of land use and land cover have been observed: land clearing for agriculture, driven by high demographic growth rates, and ecosystem evolutions driven by the rainfall deficit. Depending on the region, the combined effects of these climate and environmental changes have induced contrasted impacts on the hydrological cycle. In the Sahel, runoff and river discharges have increased despite the rainfall reduction (‘less rain, more water’, the so-called ‘Sahelian paradox’). Soil crusting and erosion have increased the runoff capacity of the watersheds so that it outperformed the rainfall deficit. Conversely, in the more humid Guinean and Sudanian regions to the south, the opposite (and expected) ‘less rain, less water’ behavior is observed, but the signature of land cover changes can hardly be detected in the hydrological records.

These observations over the past 50 years suggest that the hydrological response to climate change can not be analyzed irrespective of other concurrent changes, and primarily ecosystem dynamics and land cover changes.

There is no consensus on future rainfall trend over West Africa in IPCC projections, although a higher occurrence of extreme events (rainsstorms, dry spells) is expected. An increasing in the need for arable land and water resources is expected as well, driven by economic development and demographic growth. Based on past long-term observations on the AMMA–CATCH observatory, we explore in this work various future combinations of climate vs environmental drivers, and we infer the expected resulting trends on water resources, along the west African eco-climatic gradient.

Regional climate modelling of the West African Monsoon regime and its use for impacts and adaptation studies in Sahelian countries

ED. Poan (1); P. Gachon (1); G. Dueymes (1); E. Dianoescu (2); R. Lapanse (3); C. Sake (1); L. Seidou (4)
(1) ESCR–UQAM, Atmospheric Sciences, Montréal, Québec, Canada; (2) Environment Canada, Canadian centre for climate modelling and analysis, Montréal, Québec, Canada; (3) Université du Québec, Earth and atmospheric sciences, Montréal, Canada; (4) Centre Régional AGRHYMET/CILSS, Niamey, Niger, Republic of

In the context of climate change, increasingly applications are asked to better adjust adaptation and mitigation policies at regional and local levels. Regional Climate Models (RCMs) appear as useful tools to downscale meteorological and climate information and make it more meaningful to fulfill end-user needs. In the framework of the International Research Initiative on Adaptation to Climate Change (IRIACO) – Faire face aux Changements Ensemble (FACE), a joint effort has been carried out to investigate different aspects and repercussions of climate change on health and agriculture over the Sahelian region in view of various RCM projections. The presentation will focus on the ability of RCMs to improve the climate information at different time and space scales, with respect to large-scale boundary conditions, in particular their performance regarding the intra-annual and interannual variability of the regime. Precipitation onset, which significantly affects the agricultural activities, meteorological–scale rainy systems as well as daily precipitation indices (related to occurrence, intensity, and duration) on a daily basis, will be compared with the recent past observations showing a better agreement compared to global reanalyses and global climate models simulations. However, to be really helpful and oriented to specific applications, some aspects of RCMs, namely their physical parameterizations and/or simulated processes at the scale of meteorological systems, need improvements.

Defining genotypic adaptation targets via crop-climate modelling

J. Ramirez-Villegas (1); K. Ann-Kristin (2); A. Challinor (3)
(1) University of Leeds and CCAFS, School of earth and environment and ccafs flagship 1, Leeds, West Yorkshire, United Kingdom; (2) University of Leeds, School of earth and environment, Leeds, West Yorkshire, United Kingdom; (3) Univ. Leeds, Ccafs, Leeds, United Kingdom

Recent literature indicates that, in the absence of adaptation, on average, climate change would reduce agricultural yields globally by 2–10 % per degree of warming. Crop breeding will likely play a critical role in
agricultural system adaptation to climate change, by enhancing crop yields and improving crop quality traits. Here, we explore the role of crop-climate models in informing breeding, and identify research gaps. We focus in particular on simulation of genotypic adaptation options with crop models, focusing on the robustness of crop-climate information, with particular focus on Sub-Saharan African maize. First we present an extensive review and meta-analysis of recently published literature with regards to genotypic adaptation. Second, we develop a numerical analysis of climate information using Sub-Saharan African maize as a case study. Our review of modelling literature suggests that yield gains of up to 50% can be achieved by breeding improved varieties. However, we find that critical knowledge gaps remain if climate model information and/or model-based projections of genotypic adaptation are to be used in the development of breeding agendas. First, certain key processes and their interactions (e.g. ozone damage, CO2 stimulation, CO2 x temperature) are still poorly represented in models, largely due to a lack of understanding, thus stressing a need for further experimentation and model evaluation. Secondly, crop model parameters are often not adequately linked to the effect of alleles on given loci or genes controlling key traits. Finally, model scale mismatches and/or model misuse accompanied with poor sampling of the model and parameter space is likely to underestimate the importance of uncertainty. Assessments of robustness are therefore a critical modelling need to underpin decision-making.

For maize in Sub-Saharan Africa, we used bias-corrected CMIPs data to demonstrate that climate model information is robust at a range of scales, from sub-national (i.e. ~200×200 km) to the mega-environmental scale. With the former being the scale at which national breeding programs set their targets and the latter being the scale at which long-term international breeding goals are set, this suggests that climate model information can be transferred to both processes. We find early and robust changes in crop duration in all mega-environments but weak changes in drought and heat stress. These results suggest that crop-climate models can provide information regarding heat stress at which some (though not all) processes become important under climate change, as well as on the rates at which crop traits need to change. For some breeding programmes this might enable priority setting for breeding in a changing climate. However, if the full potential of model-based information for breeding is to be realized, more work is needed on the coupling between genetic and crop growth models, as this will ultimately result in modelled traits that are better grounded in genetic and physiological knowledge. Given the complex nature of the models needed for this endeavour, it is critical that (1) understanding of driving processes under future climates continues to improve (so that traits can be prioritised in target areas), and (2) individual model component testing against observational data is performed.

P-3330-68

Reconciling Past and Future Rainfall Trends over East Africa

D. Rowell (1); B. Booth, (1); S. Nicholson, (2); P. Good (1)
(1) Met Office Hadley Centre, Exeter, United Kingdom; (2) Florida State University, Department of earth, ocean and atmospheric science, Tallahassee, United States of America

It is well known that rainfall during the East African Long Rains season declined over recent decades, whereas the majority of climate models predict an increase due to anthropogenic carbon emissions. This raises questions about either the reliability of the model projections, or whether climate change is occurring in a way that has not been captured in climate models. We have therefore sought to compare abundant rainfall and perhaps more frequent flooding.

We first list all hypotheses that may conceivably explain this paradox, or aim to rule out all possibilities regardless of preconceptions as to their likelihood:

- A: The recent observed trend is due to poor quality data.
- B: The projected trend arises from poor modelling of key processes.
- C: Trends are due to natural variability.
- D: The balance between competing forcings is changing, with the past trend driven by aerosol emissions and the future trend driven by carbon emissions.
- E: The past trend has been driven by land-use changes.
- F: The mechanistic response to CO2 emissions is non-linear
- Some combination of the above.

Regarding A, there is good observational evidence for a recent downward trend in rainfall. Regarding B, careful and substantial further research is essential to confidently refute or accept this idea.

The possibility that the observed trend is due to natural variability (C) is assessed using two approaches. Both suggest that the recent Long Rains droughts are either due to a very unusual natural event of the climate system, or more likely are at least partly due to anthropogenic forcing. Hypothesis D, that the recent observed rainfall trend may be due to anthropogenic aerosol emissions, e.g. from Asia, is investigated using CMIP5 sensitivity experiments. These reveal a sometimes significant, but highly model-dependent, impact on SST trends over the Indian and Pacific Oceans, which are thought to have caused the recent Long Rains droughts. Other CMIP5 experiments suggest that land-use changes are unlikely to have caused the recent droughts, and that the response to CO2 forcing over East Africa is not substantially non-linear (Hypotheses E and F).

Further work should therefore focus on improving the modelling of aerosol impacts on regional rainfall changes, on providing a well-considered ‘expert judgement’ of the reliability of the model’s projections for the coming century, and better understanding the relevant natural variability.

P-3330-69

Crop-Climate ensemble scenarios to reduce uncertainty in agroclimatic risks estimation under 2°C regional warming

S. Salack (1)
(1) Karlsruhe Institute of Technology (KIT), Institute of Aerospace Engineering, Germany

The estimation of the response of rainfed crops to heat stress and water stress requires adequate accounting for the uncertainty in climatic and non-climatic factors that affect impact assessments. The objective of this research is to narrow the range of values characterizing the limits within which estimates are expected to fall in the diagnostics of agroclimatic risks. Assessments are made by analyzing historical observations and evaluating the influence of heat stress and rainfall variability on crop water demand, on biomass and on grain yields of short-cycle cultivars of pearl millet and maize. We use a wide range of consistent and practical sets of crop model ensemble analyses (based on crop management practices: seedling densities, fertilization levels, early/late sowing dates and soil types), and climate model ensembles from two climate change hypothesis (A1B & RCP8.5) over the West African Sudán–Sahel (WASS). Recent rainfall developments shows that hazardous sub-seasonal rainfall distribution affects crop productivity with increased frequency and intensity of daily rainfall, false start early cereal season and decreasing diurnal temperature range. In 2011–2050 perspectives, relative to the 1981–2010 baseline, a slight increase in temperature (i.e. +0.6 to +0.8 °C) combined with a stationary-to-moderate decrease in precipitation leads to a 10–15% (8–15%) decrease in above-ground biomass production (grain yield). When the warming is moderate (i.e. +1.4 to 1.8°C), the decline in grain yield worsens (10–20%) despite a slight increase in rainfall projections. At these rates of loss in crop production, resilience can be re-engendered. However, it will require that climate–crop management practices are embedded in short-term and interannual monitoring and early warning systems.

P-3330-70

An observatory for farmers adaptation to climate change in Thies district

A. Sall (1)
(1) Centre de Suviri Ecologique, Dakar, Senegal
In 2011, the Centre de Suivi Ecologique and Senegalese partners have developed an innovative participatory observatory. Through exchanges between researchers, policy makers, farmers organizations and NGOs in the Thies district, the observatory plays a crucial role by sharing useful information for vulnerable communities to adapt to climate variability and change. For example farmers selected millet varieties more resilient to increase yields and fodder reserves.

**P-3330-71**

**Assessment of water availability and demand in lake Guiers, Senegal**

D. Sambou (1)

(1) West African Science Center on Climate Change and Land Use– WASCAL, CRP Climate change/ Water resource, Cotonou, Benin

Water resources are critical to economic growth and social development. In most African countries, supply of drinking water to satisfy population needs is a key issue because of population growth and climate and land use change. During the last three decades, increasing population, changing patterns of water demand, and concentration of population and economic activities in urban areas has put great strain on water resources. To overcome this deficit, Senegal, turned, to the exploitation of the Lake Guiers. It is the sole water reservoir which can be used extensively as a stable freshwater source throughout the dry season, which lasts 9-10 months a year. Its water is used for irrigating crops and sugar refinery and as a drinking water resource for urban centres, including Dakar, the capital city of Senegal, as well as for the local population and animal herds.

To ensure sustainability, a greater understanding of Lake Guiers’ water resources and effective management of its use is needed. In this study we develop models and scenarios of water availability and water demand (1) Water evaluation and planning system (WEAP). The scenarios of future water availability and water demand will be developed and quantified using the water management model WEAP (Water Evaluation And Planning system).

**P-3330-72**

**A systemic approach to evaluate shea parklands as possible climate smart agriculture to be intensified in Sudanese Africa: the multidisciplinary RAMSES Project**

J. Seghieri (1); BF. Brigitte Bastide (2); G. Cesaire (3)

(1) I.R.D., DGDS–Département Environnement et Ressources, Montpellier cedex 5, France; (2) INERA, Ouagadougou, Burkina Faso; (3) INRAB, Cotonou, Benin

We have set up a project on the « Roles of shea parklands in the production of vulnerability and Agrosystems and Societies in Sub-Saharan Africa » (RAMSES) that has been submitted to several potential funders. This project ambitions to evaluate possible regeneration, extension and ecological indicators of shea production in Sudanese Africa, which is the only area supplying the international market with shea nuts (chocolate industry) and butter (cosmetic industry). By this agroforestry practices, sub-Saharan Africa will be equipped in water and biodiversity and promoted an agro-ecological approach and the MEA, diversifying their production while minimizing environmental degradation and deforestation impacts linked to extension of the cultivated areas. However, ecosystem services provided by shea trees are neither known nor quantified. Interactions between shea parklands and their associated socioeconomic systems is also currently in tension between the increasing demand and the internal trade of shea stands with increasingly limited regeneration. This results in a worrying decrease in shea production capacity while enhancing competition between farmers, between genders (women are traditionally the shea owners), and between private buyers on which the project propose a diagnosis. The project is based on multi-disciplinary investigations in two countries that are representative of the diversity of biophysical and socio-economic situations of the shea parklands, Benin and Burkina Faso. It ambitions to provide 1) a classification, with a geographic mapping support, of ecological combined to socio-economic conditions in which parklands are still viable from a past half-century diachronic and spatial analysis of their trajectory drivers; 2) under conditions where viability is questionable, an assessment of possible regeneration, (i) on ecosystem services (ii) on the farms income, by using quantification of the processes underlying services provided by trees, and a bio-economic model to simulate different trees density.

**P-3330-73**

**The ESCAPE project: an inter-disciplinary study on vulnerability, resilience and adaptation of rural societies to environmental changes in Africa**

B. Sultan (1)

(1) IRD, LOCEAN, Paris, France

Sub-Saharan Africa (SSA) is known to be particularly vulnerable to climate change due to a combination of naturally high levels of climate variability, high reliance on climate sensitive agriculture and limited economic and institutional capacity to cope with increased adaptive variability and change. Urgent actions are required to tackle the issues raised by climate change in SSA and these actions need to be supported by the best knowledge available. ESCAPE is a 5-year research project started in 2011, funded by the National Research Agency which aims to revalorize research in SSA in this field through an integrated interdisciplinary framework for increasing our understanding of the problem and supporting decisions for the future. ESCAPE addresses the vulnerability of rural societies in SSA to climate and environmental changes and explores adaptation pathways to reduce this vulnerability. The project fosters interdisciplinary research, through both retrospective and prospective studies, in Senegal, Niger, Benin and Mali, on the evolution of different agricultural, ecological and social systems interacting together under the global environmental changes.

**P-3330-74**

**The easterly water vapour transport from Indian monsoon and its role in the variability of west african monsoon**

A. Sy (1); D. B. (2)

(1) University Gaston Berger, Saint-Louis, Saint-Louis, Senegal; (2) University Gaston Berger, Saint-Louis, Saint-Louis, Senegal

West Africa region is one of the poorest in the world and most of its economic activities depend on the rainy season. In Sahel region and in its neighboring regions and transported by prevailing atmosphere in Sahel could come from the Indian monsoon and its role in the variability of West African monsoon. For this work we used ECMWF datasets, daily averages wind and humidity measured at 200hPa–1000hPa levels pressure and daily average OLR (Outgoing Longwave Radiation) NCEP / NCAR and 2.5x2.5 the rainy season June–July–August–September during the period 2001–2010. The study focused on 20°W–90°E Longitude 0°–30°N Latitude area covering West Africa to India. The water
vapour column available in West Africa is the result of a contribution from the south-westerly monsoon (1000–850 hPa) on one hand and easterly fluxes (850–300 hPa) on the other hand (R. Meynadier 2010 Dème A. 2002, De Felice et al 1982). To detect and study the fluxes supposed to come from the ocean, we consider the top (500–300 hPa) of the high layer knowing that the middle layer (850–500 hPa) brings water vapour through the African Easterly Jet.

We have calculated the fluxes from qV (When q: Specific Humidity, V = u + v zonal and Meridional wind).

We performed Hövmoeller diagrams of fluxes computed on 500–300 hPa layers and it appears very clear so water vapour advection in the upper layers of the altitude to Africa from joining the column available water.

These water vapour movements have an intra-seasonal and inter-annual variability during the 2001–2003 and 2006–2010 periods. The water vapour fluxes calculated on the 450–700 hPa area longitude and latitude 100N–20ON are oriented towards Africa and reach a maximum of about 25 kg/m/s during the summers from 2001 to 2003 and a maximum of 36 kg/m/s observed in 2010 August.

To follow these fluxes up to the Sahel we considered the 400–500 hPa and 150–350 hPa area further west, on 50N–200N latitude. We noted an increasing of the quantities of westward water vapour advected in this part of the troposphere during the years studied. In June 2010 low values of olr (cloudiness) in Chad appear between 3 to 5 days after the initiation in India of a westerly flow. The lowest values of olr observed in Chad in late August 2010 follow relatively large amounts (33; 36 kg/m/s) of water vapour flux from India.

P-3330-75
Impact of Climate Change on Freshwater availability for Senegal: Modeling Future Changes in Hydro-climatology of Lake of Guiers
M. Tall (1) ; I. Diallo (2) ; MB. Sylla (3) ; A. Gaye (4)

(1) Laboratoire de Physique de l’atmosphère et de l’Océan Simeon-Fongang (LPAO-SF), Ecole Supérieure Polytechnique (ESP) / Université Cheikh Anta Diop (UCAD), Dakar, Senegal; (2) Université Cheikh Anta Diop, Ecole supérieure polytechnique, Dakar, Senegal; (3) WASCAL Competence Center, Climate Modeling and Climate Change, Ouagadougou, Burkina Faso; (4) Univ. Cheikh Anta Diop, Lpaosf, Dakar, Senegal

The future climate change could have a major impact on the hydrological systems. The hydroclimatology of the northern Senegal, especially over the basin of the lake Guiers (North Senegal) for the present and the late 21st century has been analyzed; based on simulation from the Regional Climate Model (RCM) RegCM4. RegCM4 simulations have been performed with a horizontal resolution of 25 km (0.22 X 0.22) for the 1985–2004 period and 2080–2099 period under both the Rcp4.5 and RCP8.5 emission scenario over the West African domain. Initial and lateral boundary conditions are taken from the ECHAM6 Earth System Model. Overall RegCM4 reproduces reasonably the spatial distribution of precipitations and temperatures as well as its month-to-month variations over both the present and the late 21st century. RegCM4 projects with both emission scenarios a rising of temperatures and a decrease of the rainfall in the late 21st century. Therefore the rising of temperature as well as the weakening of rainfall is rare intense in the scenario RCP8.5. On the other hand, RegCM4 projects an evaporation decrease over the lake basin reaching up to 40% under the RCP8.5 emission scenario followed by an enhancement of runoff over the lake basin and the north of Senegal. This increase of runoff would result probably from the either the enhancement of the aridity by the end of 21st century or and from probably an increase of extreme events such as heavy rains.

P-3330-76
Effect of seasonal variability on the incidence and transmission patterns of malaria in urban, peri-urban and rural communities around Kumasi, Ghana
S. Tay (1)
(1) School of Medical Sciences Kwame Nkrumah University of Science & Technology, Department of Clinical Microbiology, Kumasi, Ghana

Changes in temperature, rainfall and relative humidity are expected to influence malaria directly, by modifying the behaviour and geographical distribution of malaria vectors and by increasing or decreasing the length of the cycle of the parasites, and also indirectly, by investigating the impact of these changes on malaria incidence in the Kumasi metropolis and a rural district in the Ashanti region, Ghana. Data on climatic variables from December 2009–2011 were obtained from the Owabi, Emena and Airport weather stations. Data on malaria cases from December 2009–November 2011 were obtained from Nkwai hospital (near Owabi weather station), Aninwaa Medical Centre (near the KNUT Weather station) and Manhyia hospital (near Airport weather station) from December 2009–November 2011. Based on malaria morbidity data, three communities were screened and two were chosen for study: two months of each season were selected and they were May 2010 and August 2010, based on the seasonal variation of rainfall. Malaria vectors were captured using the WHO standard light trap (Spray catch method). Data analysis was conducted with Microsoft Excel and Statistical Software Package, SPSS version (16.0). Pearson’s correlation analysis was done to establish the relationship between climatic variables and malaria transmission. In the communities, Anopheles gambiae was the highest mosquito vector caught with few or no Anopheles funestus over 60% of which were fed with the dry season and Anopheles arabiensis in the highest percentage of fed mosquitoes. Over 90% of the fed mosquitoes had fed on human blood. Sporozoite rates for Nkwai were 6% between April and July 2011, 5.6% between August and November 2011 and 5.6% between November 2011 and March 2011. In Emena, the rates were 4.0%, 5.0% and 3.0% between April and July 2011, August and November 2011 and December 2011 and March 2011 respectively. The annual Entomological inoculation rates (EIR) for Nkwai were 245.6, 203.6 and 52.4ib/p/yr April and May, August and November and December 2010 and March 2011. In Emena, August to November recorded the highest annual EIR of 182.5ib/p/yr, followed by April to July with a value of 175.2ib/p/yr and then December 2010 to March 2011 with 94.9ib/p/yr. In Asawasi, April to July recorded the highest annual EIR of 245.4ib/p/yr followed by August to November and December 2010 and March 2011 with 229.9ib/p/yr and 109.5ib/p/yr respectively. There were direct relationships between minimum temperature and human bite rate, maximum temperature and sporozoite rates, rainfall and number of mosquitoes caught during the study period and between malaria incidence and the entomological inoculation rate. There were also indirect relationships between maximum temperature and the number of mosquitoes caught. This research shows that malaria transmission is caused by a multiplicity of factors including climatic, environmental, biological, behavioral and socioeconomic factors. These factors play diverse roles on malaria vector biology as well as on the parasite.

P-3330-77
Multi-decadal variability of Sahel Rainfall and African Easterly Waves in CMIP5 Models: Mechanisms, Model Fidelity and Implications for Future Climate Change Projections
C. Thornicroft (1) ; E. Martin, (2)
(1) Professor, University at Albany, Dept. of Atmospheric and Environmental Sciences, Albany, United States of America
(2) The University of Oklahoma, School of meteorology, Norman, United States of America

This study uses models from phase 5 of the Coupled Model Intercomparison Project (CMIP5) to evaluate and investigate multi-decadal variability of Sahel rainfall and teleconnections with global sea surface temperatures (SSTs). The simulated Sahel easterly waves (SEWs) in the CMIP5 models is also evaluated as part of this work. Multi-decadal variability of Sahel rainfall is lower than observed in all historical simulations evaluated. Focus is on teleconnections with North Atlantic SST [Atlantic multidecadal variability (AMV)] as it is more successfully simulated than the Indian Ocean teleconnection. To investigate why some models successfully simulated this teleconnection and others did not, despite having similarly
large AMV, two groups of models were selected. Models with leading AMV were highlighted as good (or poor) by their ability to simulate relatively high (low) Sahel multidecadal variability and have significant (not significant) correlation between multidecadal Sahel rainfall and an AMV index. Poor models fail to capture the teleconnection between the AMV and Sahel rainfall because the spatial distribution of SST multidecadal variability across the North Atlantic is incorrect. A lack of SST signal in the tropical North Atlantic changes the model’s ability to accurately predict the Sahelian SST gradient and, through circulation changes, the rainfall variability in the Sahel. This pattern was also evident in the control simulations, where SST and Sahel rainfall variability were significantly weaker than historical simulations. The reasons for these errors will be discussed.

African easterly waves are the major synoptic weather producer in the Sahelian region and the extent to which CMIP5 models represent them is important to know. Changes in AEW-activity may be expected to impact the frequency of extreme rainfall occurrence for example. Large biases in the lifetime and number of AEWs in each season are present in CMIP5 historical simulations. CMIP5 models simulate excessive AEWs over the period 1980-1990 and deficient rainfall over the period 1990-2000. The simulation of AEWs is challenging for CMIP5 models and must be further explored in order to provide appropriate confidence levels of rainfall projections in the Sahel.

Recent trends in the regime of extreme rainfall in the Central Sahel

T. Vischel (1) ; G. Panthou (1) ; T. Lebel (1)
(1) Université Grenoble Alpes, Lth, Saint Martin d’Hères, France

Ongoing global warming raises the hypothesis of an intensification of the hydrologic cycle, extreme rainfall events becoming more frequent. However, the strong time-space variability of extreme rainfall makes it difficult to detect meaningful trends in the regime of their occurrence for recent years. Using an integrated regional approach, it is shown here that, over the last ten years, the Central Sahel region is characterized by a large deficit of the number of rainy days, while at the same time the extreme rainfall occurrence is on the rise. As a consequence the proportion of rainfall associated with extreme rainfall has increased from 17% in the 1970–1990 years to 19% in the 1991–2000 years and to 21% in the 2001–2010 years. This tends to support the idea that a more extreme climate has been observed over 2001–2010: this climate is drier in the sense of a persisting deficit of rainfall occurrence compared to 1950–1969, while at the same time there is an increased probability of extreme daily rainfall.

Climate Change and Agricultural Production: capitalisation of the farming techniques for the food security in Benin

JB. Vodounou (1)
(1) University of Parakou, Département de Géographie et Aménagement du Territoire, Parakou, Benin, Benin

The capitalization of the farming techniques for food security in Benin has been studied. The effects of climate change have impacted the farming techniques of the populations in order to adapt to the new conditions imposed by climate change. These changes have modified not only the dates of seedling but also the abandonment of some speculations. In order to ensure their food security, the populations have proceeded to a revision of their farming techniques. The situation in Benin can be summarized as follows three zones (North, Centre and South). As a matter of fact, in the north 40% of the yielded speculations today can be considered as introduced twenty years ago. In this area in the years 60s there are crops such as yam, voandzou, maize, peanuts, and garden pea. The current crops are yam, maize, and sorghum. Crops such as pepper, voandzou and garden peas are more withdrawn from the speculation ranges. Furthermore, the situation in the centre of Benin is enough animated. In effect, about 65% yielded speculations in the past were abandoned at the present and the new estimated ones more adapted to the current climatic conditions. To ensure their food security, the populations of this zone have spared the speculations such as maize, yam, and peanut. Crops such as sorghum, millet, voandzou and garden peas are more withdrawn from the speculation ranges. But one must understand that in majority the south depends much more on the centre and north as regard food crops.

Role of groundwater in buffering changes in climatic and anthropogenic conditions: experiences from Sub-Saharan Africa

JM. Vouillamoiz (1) ; C. Tidimmugaya (2)
(1) IRD, Irdf/juf–grenouille-1/cnr5/g-imp – umr lthe, Cotonou, Benin; (2) Ministry of water and environment, Commissioner for water resources planning and regulation, Kampala, Uganda

Currently, more than 300 million people in Africa do not have access to safe drinking water. Expanding irrigation to enhance food security is also a growing necessity. Moreover, most countries where population is expected to grow rapidly in the future are the same countries that have high levels of malnourishment and also limited access to drinking water. The proportion of the population that depends on groundwater for its daily water supply is estimated at about 75%. In the future, the ability to increase reliable access to water supplies will also depend on the development of groundwater, which is generally the only perennial water source in arid and semi-arid regions. One of the most important advantages of groundwater as compared to surface water is its much slower response to climate and anthropogenic changes. Indeed, the amount of water stored in the rock reservoir buffers the transient response of the system to conditions that vary over time, and hence groundwater supplies in Africa can significantly increase the resilience of communities to climate variability.

One of the most important difficulties in assessing groundwater resources is that groundwater is underground and hence hidden from our eyes. Reliable quantification of groundwater storage and recharge is not straightforward. Moreover, the project taking into account that groundwater recharge obtained from large-scale models are uncertain, and the scale of models is not appropriate to groundwater systems which are highly spatially heterogeneous over large part of Africa surface area where hard rock aquifers occur.

To illustrate the role groundwater can play in buffering changes, we present the results of a study carried out in Benin in a widespread environment of Sub-Saharan Africa (i.e. hard rock aquifers). Thanks to a novel approach, we determined the groundwater storage of our study area (27,200km²) to be 440mm +/- 70mm. To assess the buffer capacity of aquifers, we compared groundwater storage to groundwater discharge. Groundwater discharge is the sum of natural discharge plus human abstraction. We evaluated human abstraction at less than 1% of total groundwater discharge. We conclude that increased abstraction due to climate and anthropogenic changes. Indeed, the amount of water stored in the rock reservoir buffers the transient response of the system to conditions that vary over time, and hence groundwater supplies in Africa can significantly increase the resilience of communities to climate variability.

To illustrate the role groundwater can play in buffering changes, we present the results of a study carried out in Benin in a widespread environment of Sub-Saharan Africa (i.e. hard rock aquifers). Thanks to a novel approach, we determined the groundwater storage of our study area (27,200km²) to be 440mm +/- 70mm. To assess the buffer capacity of aquifers, we compared groundwater storage to groundwater discharge. Groundwater discharge is the sum of natural discharge plus human abstraction. We evaluated human abstraction at less than 1% of total groundwater discharge. We conclude that increased abstraction due to population growth will probably have a small impact on storage. We calculated the buffer capacity as the ratio of current storage to total discharge, and obtained a result of 6years +/- 47months. This buffer capacity confirms groundwater’s ability to buffer changes. Finally, our study is an important step towards a quantitative approach to assessing groundwater resources and to support our ability to adapt to future changes.
Heat effects of ambient apparent temperature on total non-accidental mortality in Cape Town, Durban and Johannesburg, South Africa: 2006-2010

J. Wichmann (1)
(1) University of Pretoria, School of Health Systems and Public Health, Pretoria, Gauteng, South Africa

INTRODUCTION

Although many studies of temperature have been conducted in other disciplines such as climatology, they have only received greater attention in public health and epidemiology in the past decade. However, very few studies have been conducted in Africa and none which also controlled for possible confounding by air pollution. Epidemiological studies are crucial to understand possible local human health impacts due to climate change, and to the development of adaptation strategies to mitigate such impacts.

METHODS

The objective of this study was to investigate the influence of heat effects of ambient apparent temperature (Tapp) on total non-accidental mortality in Cape Town, Durban and Johannesburg, South Africa (2006-2010) using the time-series and case-crossover epidemiological study designs. The heat effect was investigated for apparent temperature above the city threshold, 15°C, 20°C and 13°C for Cape Town, Durban and Johannesburg, respectively. Three cities are classified in different Köppen-Geiger climatic zones: Cape Town has a Mediterranean climate (Csb), Durban has a humid tropical climate (Cfa), that closely borders a tropical wet and dry climate (Aw). Johannesburg has a subtropical highland climate (Cwb).

RESULTS

In Cape Town, total non-accidental mortality significantly increased by 1.1% and 2.1% for all ages (60228 deaths) and >60 year olds (28383 deaths), respectively per °C increase in Tapp above lag0-1. No heat effect was observed for 0-4 year olds (4649 deaths). The maximum Tapp (lag0-1) observed was 27°C.

In Durban, total non-accidental mortality significantly increased by 1.0%, 1.4% and 1.9% for all ages (95269 deaths), >60 year olds (28801 deaths) and 0-4 year olds (8628 deaths), respectively per °C increase in Tapp above 20°C (lag0-1). The maximum Tapp (lag0-1) observed was 31°C.

In Johannesburg, total non-accidental mortality significantly increased by 0.5% and 2.2% for all ages (9490 deaths) and >60 year olds (31859 deaths), respectively per °C increase in Tapp above 13°C (lag0-1). No heat effect was observed for 0-4 year olds (10080 deaths). The maximum Tapp (lag0-1) observed was 24°C.

CONCLUSION

These results indicate that the health of the South African population living in Cape Town, Durban and Johannesburg is at risk with increases in Tapp. The study will be expanded to include four other South African cities located in different Köppen-Geiger climatic zones. Cause-specific mortality, such as respiratory and cardiovascular mortality, will also be investigated.

P-3330-83

Interaction between moist Kelvin waves and synoptic variability of precipitation over Congo basin

S. Zebaze (1); L. Andre (2); T. Clément (1); S. Janicot (1)
(1) UNIVERSITY OF YAOUNDE I, PHYSICS, YAOUNDE, Cameroon; (2) University of Douala, Physics, Douala, Cameroon

The synoptic structure and variability of moist synoptic Kelvin waves over the Congo basin during March to June (1979-2010) are explored using satellite-observed brightness temperature (TB), outgoing longwave radiation (OLR) and National Centers for Environmental Prediction-National Center for Atmospheric Research (NCEP-NCAR) reanalysis data. We found that synoptic Kelvin waves (SKWs) activity is most predominant during March-May and it is centered at the equator where the convective active phase of these waves favors formation of convective synoptic systems. A brief analysis of an intense Kelvin wave in March-May 1999 (active year) shows a clear impact of the wave on convective development and daily rainfall over Congo basin. Convection is found to be less frequent immediately prior to the passage of the convectively active phase of the wave. This convective activity over the equatorial Kelvin wave (CKKW), more frequent during the passage, and most frequent just after the passage. Otherwise, Results show marked interannual variability of Kelvin wave activity over Congo basin. The large synoptic variability of precipitation is observed from March-May which clearly denotes synoptic activity in this region. Interannual variability in the fluctuation strength of the wave power spectrum as well as in its distribution amount different periods. Strong signals clearly found at period between 4-6 days and 7-9 days. The location of peak SKWs convection is consistent with high rainfall location and clearly impacted crops yield over this region.
Extreme condition and climate change in northern Africa during the last century

YD. Zéphirin (1); M. David (2); C. Romeo (3)
(1) Institut National de Cartographie, Service de climatologie, Yaounde, France; (2) Université de Douala, Cameroon; (3) Université de Yaoundé I, Département de physique, Yaoundé, Cameroon

Four homogenous climatic zones are detected in northern Africa (20°W-40°E, 0-30°N) by applying the Cluster Analysis (CA) method on the rainfall anomalies data from the Climatic Research Unit (CRU). The four climatic zones are distributed into Saharan, Sahelian, wet tropical and equatorial climate types. The application of a segment of 15 years with overlap going from 1901-1940 (P0), and 1961 to 2000 (P4) throughout the periods 1916-1955 (P1), 1931-1970 (P2) and 1946-1985 (P3), shows important spatial-temporal modifications of rainfall zones south of 15°N. The semi-arid zones (sahelian) which govern the dynamics of this zone doubled at the end of the twentieth century, while the wet tropical and equatorial zones decreased at the half.

Temperature trends have a magnitude of up to 1.5 K per century in all the four climatic zones. This warming was mainly observed during the last three decades (P3). The analysis of the rainfall shows that the timescale of variability which is governed by 3 main periodicity bands: less than 5 years, from 5 to 30 years and above 30 years.

The extreme conditions in temperature and the precipitation were analysed in terms of their persistence. The sporadic long-lasting extreme conditions appear for several years to over 10 years during the last century.

Forest landscape management to create resilience in the face of climate change in West and Central Africa

L. Verchot (1); Dj. Sonwa (2); K. Fernandes (3); W. Baethgen, (4); M. Pinedo-Vasquez, (1)
(1) CIFOR, Bogor, Indonesia; (2) CIFOR (Center for International Forestry Research), Yaoundé, Cameroon; (3) Columbia University, International Research Institute for Climate and Society (IRI), Palisades, NY, United States of America; (4) Columbia University, International Institute for climate and society, Palisades, NY, United States of America

Deforestation in West and Central Africa is driven by economic concerns, primarily associated with the expansion of agriculture. Recent suggestions that deforestation is increasing in Africa are drawing attention for the associated emissions. There has been a lot of discussion and agreement among scientists about the importance of forests in these regions for carbon sequestration. The potential role of forests in adapting to the stresses associated with climate variability and change are less well understood. For example, none of the Congo Basin countries highlighted potential impacts of climate change on forests as a source of national vulnerability in their first national communications to the UNFCCC. Yet, evidence is accumulating that climate change has begun to affect the growth and condition of the Congo Basin forests and this will affect communities that depend on these forests for goods and services. A large number of stakeholders believe that climate change and climate variability do not threaten the forest ecosystems in the humid parts of the region. Threats are more readily recognized in the sub-humid and semi-arid regions. Other stakeholders contend that climate change adaptation needs to pay attention to the role forests play in landscapes and there are different opinions about whether adaptation and mitigation need to be considered separately or together. Finally, when we talk about forests, mitigation and adaptation concerns often go hand in hand. This talk will look at the changing nature of climate and climate variability in the region and posit a number of climatic associated risks for local livelihoods and economic development. We will then look at the goods and services provided by forests and examine the evidence that forests have an important role to play in resilience to climate variability and change. Finally, we will look at how adaptation interests can be served by increasing tree plantations in rural African landscapes.

The Great Green Wall for the Sahara and the Sahel within the context of Climate Change

M. Malagnoux (1)
(1) French Scientific Committee on Desertification, Allinges, France

Common perception of desertification is the advancement of the desert through sand encroachment on fertile lands. Many images of the desert invading its surrounding lands are widespread in the general public. The idea of halting the desert by planting linear barriers of trees, shrubs and grass, is based on many historical or recent successful examples of shelter belts and greenbelts protecting towns, infrastructures, oases and other fertile lands from shifting sands. In this context, successful techniques at very local level could not be applied at large scale to halt the desert expansion? Large scale linear barriers have been proposed to control the northern and southern rims of the Sahara. The Algerian Green Barrier is an example of this approach.

However, desertification is defined by the UNCCD as “land degradation in arid, semiarid and dry sub humid areas resulting from various factors, including climatic variations and human activities”. Consequently, desertification is not an advance of existing deserts but rather the effect of localized degradation of the land. It follows deforestation, overgrazing or soil exhaustion due to the over exploitation of natural resources. Thus, desertification cannot be controlled by planting tree lines to keep desertification at bay. China launched in 1978 a large scale integrated management programme in an area of over 4 000 km long by almost 1 000 km wide named “The Three North Shelter Belt Project”. In 1989, President Deng Xiaoping called this the “Green Great Wall” in reference to the ancient “Great Wall” of China, to highlight the scope of the work. But it is by no way a bulwark against the desert despite what this nickname suggests.

The Great Green Wall for the Sahara and the Sahel (GGW) launched by the African Union builds on these past experiences and aims at testing while others have a stable environment where no action is needed. The continuity of the belt is not required. On the other side, areas outside the belt may need urgent action and the belt represents a small portion of the affected area of Sahelian countries. The effects of GGW will be limited to the areas under management. Thus, regarding the adaptation of the Sahelian countries to climate change and the mitigation of GGW effects, the Great Green Wall for the Sahara should be a driving example for the extension of the activities to all the degraded or endangered areas of the whole Sahel.
O-3331-01

Adaptive capacity and tree-based livelihood diversification strategies of smallholders in Central Burkina Faso

INS. Djenontin (1); H. Djoudi (2); M. Zida (1)
(1) Center for International Forestry Research, Forest and Livelihoods Portfolio, West Africa team, Ouagadougou, Burkina Faso, Burkina Faso; (2) Center for International Forestry Research, Forest and livelihoods portfolio, Bogor, Indonesia

Ecosystem-based adaptation strategies are increasingly gaining attention, among researchers and development practitioners, as a diversification option to address climate change. Informed decision on the adequacy of ecosystem-based strategies requires an understanding of the social and environmental contexts that allow households to seek to build resilience toward climate’s adverse impacts. This paper analyzes how different trees and forest-based diversification strategies affect household’s adaptive capacity in Central Burkina Faso. It uses an integrated approach to select indicators at a household scale, and calculates an aggregate adaptive capacity index (ACI) derived from a combination of both sub-aggregate and subcomposite indexes. Existing ecosystem-based strategies were first identified, and the analyses are done on a sample of 129 representative households who use four different forest and tree-based diversification strategies. Households were interviewed on their assets endowment as well as on the different livelihood outcomes achieved while implementing the strategy. The perceived sensitivity of the strategies to climate risks is also assessed. A cross-comparison of ACI of households under each strategy indicates that while households who engage in eucalyptus plantations benefit a low adaptive capacity increment, those who engage in restored land, niger tree, and fruit tree plantations have a high adaptive capacity index. The calculated ACI is 4.78 for households who implement restored land strategy, 4.58 for those using main plantation strategy, 4.35 for those who engage in cashew plantations strategy, and 4.31 for households who engage in eucalyptus plantations strategy. However, it is important to put on perspective the adaptive capacity index of households using fruit tree plantations, considering the overall situation of environment and biodiversity lost. Restored land shows a better diversity in terms of products harvested, which are available at different times during the year while fruit tree plantations produce a higher economic gain but their role as a safety net in a case of crisis is low and their sensitivity is higher. The integration adaptive capacity analysis to implement ecosystem based interventions could enhance the climate resilience capacity by improving the adaptive capacity of communities and individuals.

O-3331-02

The Great Green Wall: a potential driver of transformation and increased resilience in Sahelian landscapes

D. Goffner (1); A. Guissé (2); JL. Peiry (3); P. Duboz (1); G. Boetsch (4)
(1) CNRS, International Research Unit CNRS 3189 Environment, health, Societies, Marseille, France; (2) Cheikh Anta Diop University, Plant ecology, Dakar, Senegal; (3) Blaise Pascal University, Geolab, Clermont–Ferrand, France; (4) CNRS, International research unit cnrs 3189, environment, health, societies, Dakar, Senegal

The African Sahel is one of the most vulnerable regions on Earth. Although it is comprised of highly diverse landscapes, the increasing ecological and social vulnerability is clearly the common denominator of the entire zone, translating into an urgent call for action. The currently observed trajectories, driven by a downward spiral: vulnerability has been caused by a combination of climatic and human factors resulting in land degradation, which in turn further accentuates human vulnerability. In order to contrast this distress for the growing populations of the Sahel, innovative, multi-scale strategies must be implemented. The adoption of the Great Green Wall for the Sahara and the Sahel Initiative (GGW) in 2007 is a step in the right direction. For the first time, the African continent stand united to confront the socio-ecological challenges of the Sahel and Sahara. Since its political adoption, the main objective of human and ecological well-being has remained unchanged. From its original configuration of eleven founding member countries across the Sahel, it has gradually begun merging with other ongoing, sustainable development initiatives throughout the African continent, thereby creating even greater potential force. Importantly, it has evolved from its original raison d’être as primarily a reforestation project, to a series of multi-sectorial actions that takes into account the diversity of the mosaic landscape it crosses.

The success of the GGW will depend on its capacity to intelligently gather, generate, integrate, and use knowledge derived from a wide range of disciplines, taking into account the nature and complexity of socio-ecological systems. How can scientific research in the GGW context nudge the GGW into an appropriate trajectory for transformation of the Sahel? To respond to this demand, the GGW Human Environment Observatory was created by the French National Centre for Scientific Research (CNRS) in 2009 and groups together international researchers from a wide range of scientific disciplines, all working on a common social ecological system located in the Senegalese Sahel. Research is carried out in close collaboration with natural resource decision makers for the GGW in Senegal (The Senegalese National Green Wall Agency), and in conjunction with local populations. In this presentation, several examples of how scientific research outputs, including ecological restoration and monitoring, as well as health and social impacts of the GGW will be presented by observatory researchers. We will provide examples as to how science is already contributing to ecological and human well-being in the region and how scientific data are directly translating into action on the ground and aid in the larger management decisions with the aim of enhancing the resilience of local populations by attempting to provide the appropriate suites of ecosystem services in an equitable manner.

O-3331-03

Implementing REDD+ and adaptation to climate change in the Congo Basin: Review of projects, initiatives and opportunities for synergies

AM. Tiani (1); C. Pavageau, (1)
(1) CIFOR, Yaounde, Cameroon

In the face of the climate change, two main types of strategies have emerged. While mitigation aims to reduce the sources of greenhouse gas emissions, adaptation addresses the impacts of climate change on societies and ecosystems. Even if adaptation is gaining importance in the international arena, national policies and projects have diversity. One of the main challenges is to develop concrete adaptation measures for the current and future climate change. Moreover, forests and forest communities are rarely taken into consideration in debates and policies on adaptation. In addition, Congo Basin countries have limited experiences on REDD+ and adaptation working together, but few life-size experiments can confirm it.

We explored the state of progress of projects and initiatives to promote adaptation and REDD+ in the Congo Basin region and analyzed opportunities for synergies or trade-off between the two strategies. Between 2008 and 2013, 94 national programs and activities related to REDD+ and 11 on adaptation have been identified in six countries of the Congo Basin. Most projects are at an early stage with more emphasize on REDD+ than on adaptation, due to uncertainties about spatiotemporal patterns of risk occurrence, lack of clear adaptation solutions, insufficient political support or lack of national structuring framework as REDD+ does.

Two main tendencies emerged from REDD+ initiatives: 1) local demonstration activities directly aim to reduce carbon emission from deforestation, forest degradation, and sustainable forest management and increase carbon stock; 2) reforestations activities at local scale and international framework for countries to participate in REDD+ deals and develop strategies accordingly. Adaptation to climate change and REDD+ evolves as two parallel and similar processes. Potentially, the two processes exists but are not fully recognized yet.

To be noted is the emergence of hybrid approach where most of REDD+ and adaptation projects intend to combine the integrated conservation and development
Could IFM REDD+ projects incentivize forest concessionaires to reduce greenhouse gases emissions in Central Africa? A lesson from the FORAFAMA project

F. Claeyts (1) ; V. Rossi (2) ; D. Bastin (3) ; R. Eba’a-Atyi (4) ; S. Gourlet-Fleury (1) ; G. Lesucyer (5) ; N. Picard (2) ; DJ. Sonwa (4)

(1) Centre for International Cooperation in Agricultural Research for Development (CIRAD), Tropical Forest Goods and Ecosystem Services (BSEF), Montpellier, France; (2) Centre for International Cooperation in Agricultural Research for Development (CIRAD), Tropical forest goods and ecosystem services (bsef), Yaounde, Cameroon; (3) Institute of Development (Cirad), tropical Forest Goods and ecosystem services (bsef), Bogor, Indonesia

Improved Forest Management (IFM) is an activity eligible to the mechanism of Reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries (REDD+). In this context, IFM refers to activities that increase carbon stock on managed forest lands by changing forest management practices. As nearly 20 million hectares are now managed in the Congo Basin forests, it is a strategy of prime importance in climate policies of Central African states. However, the carbon benefit is generally based on a decrease of felling intensity that means severe income shortfalls for the logger. The extent to which carbon can compensate losses of timber income is a decisive factor in the feasibility of REDD+ projects. Given the few number of scientific studies on this subject, and the even fewer number of pilot projects that have been implemented, this issue is still highly in debate.

We assessed the potentialities for emissions reductions of IFM REDD+ projects and evaluated their financial feasibility. We explored a broad range of scenarios for reducing logging intensity in a typical export-oriented forest concession in Central Africa. For each scenario and for several carbon accounting approaches, we calculated timber income shortfalls and carbon benefit to forest concessionaires to reduce green-house gases emissions in Central Africa. For example, under the assumptions that carbon credit prices are $20 per ton of carbon dioxide equivalent and the timber price is $200 per cubic meter, a concession that logged to protected Forest (LTPF) projects, would log 1,000 cubic meters, with a total value of $200,000. If the concessionaire invests in a project to reduce logging to 50% of the original, the carbon benefit would be $20,000, resulting in substantial savings. The feasibility of other IFM REDD+ projects is particularly constrained by the current approach to addressing the risk of non-permanence. As an example under the Certified Carbon Standard (VCS), the maximum number of Voluntary Certified Units (VCU) available to projects including harvesting, cannot exceed the long-term average carbon benefit. In the Clean Development Mechanism (CDM), an other approach to deal with non-permanency had been proposed with temporary Certified Emission Reductions (tCER). A tCER expires at the end of the commitment period ending its issue. Such an approach, that can allow to value the storage of carbon even on short time periods, is much more flexible and adapted to permanent timber production tropical forests. However, even under this methodology, REDD+ projects prove to be unattractive for Central African timber companies as their feasibility remains conditioned to a major reduction of logging intensity. Otherwise, projects are severely penalized by transaction costs and low carbon differentials.

Our work suggests that current methodologies of voluntary standards are not well appropriate to include IFM within REDD+. Instead of incentivizing to consolidate timber production and carbon sequestration, IFM REDD+ projects rather encourage forest concessionaires to value either carbon or timber exclusively, thus ignoring the trade-offs and additionality issues. To promote the deployment of a truly climate-smart forest management, the incentive system should focus more on practice changes than only on the result expressed in permanently avoided emissions.
(4) recommended approach to “avoid the tragedy of the commons” in community forestry in the Nzoia basin under current climate change conditions in Kenya.

P-3331-03

Risks and opportunities of Eucalyptus planting (Case study in the framework of the GIZ-German-Madagascan Environmental program)

L. Prill (1) ; D. Plugge (1)
(1) Institute for World Forestry, University of Hamburg, Hamburg, Germany

Growing biomass for rural (energy) purposes in highly productive planted forests can contribute to the preservation of natural forests, the mitigation of climate change and the rehabilitation of degraded land and biodiversity – provided that they are appropriately planned and managed. Since 1996 in North-Madagascar ~7.000ha of former degraded savannah have been afforested with Eucalyptus within the “German Madagascan environmental program” of the “Deutsche Gesellschaft für Internationale Zusammenarbeit” (GIZ) GmbH to supply the Diana Region with sustainable wood energy (charcoal). The GIZ-community-based afforestation approach aims to develop a sustainable charcoal value chain in Madagascar.

Despite the manifold opportunities, cultivating Eucalyptus has often been associated with environmental and ecological impacts that negatively affect environmental sustainability of afforestation projects. Little research in this context was done in Madagascar. Based on a case study the present study aims to analyse ecological risks and opportunities of planting Eucalyptus in projects to promote renewable energy resources in rural areas. Floristic diversity and soil properties of 21 different-aged and -managed Eucalyptus camaldulensis (EC) plantations and adjacent savannah sites around three different villages in the Diana Region were analysed and compared. Research on biodiversity was based on the parameters: species richness (number of species, ”sp” ), plant frequency (plants/hectare), Shannon Diversity (H') and the species composition of predominating plants of woody and ground cover (GV) species. Soil samples of plantation and savannah sites were analysed for their pH value and carbon to nitrogen ratio. Special regard was given to spatial, temporal and management intervention effects. This was achieved by sampling EC–stands with different stand characteristics (e.g. stand age) and through the design of the chosen transect-sample unit.

Soil properties did not vary significantly between savannah and plantation sites although stand volume per hectare and partly stand age negatively affected both soil properties.

In all villages absolute recorded number of woody species was higher in the savannahs than in the plantations whereas GV–species richness was relatively even. Mean woody spR and H' were further elevated in the savannah–units while mean plant frequency was partly higher in the plantation–units. Differences were not significant. Species composition was similar between savannah and EC–stands. Stand density and/or –volume positively affected diversity while plant frequency decreased with higher stand density in some cases. No spatial and temporal effects could further be observed in the study region. This low response is likely due to human intervention and cattle grazing that reduce plant regeneration. Differences in terms of diversity conditions were, however, apparent between the investigated villages. Variations in the distance to remnants of natural forests and site conditions (e.g. soil) of plantations are likely to play a key role in this context.

Plantations established on degraded land in North- Madagascar may help to protect natural forests and its biodiversity, thereby help to mitigate climate change and increase the value of degraded land. Results indicate that impacts of EC-stands on biodiversity and soils are small and that the plantations are further able to provide habitat for many (including the predominating) species of the savannah. Nevertheless, a trend towards a reduced diversity in the plantation was observed. In order to reduce the risk of diversity loss further research should focus on the potential of mixed–species stands in the project region including native species with a high relevance for the local population. In this context, also the role of remnants of natural forests and seed dispersal methods should be assessed.

Recent developments have shown that programs that avoid deforestation by supplying local needs such as the presented approach of the GIZ will gain further importance in the future. Considering the expanding land area covered with eucalyptus, the objective of enhancing biodiversity and other (ecosystem) services should therefore be incorporated in the land–use planning of programs to promote renewable energy resources in rural areas.

P-3331-04

Forest Ecosystem as Strategies to Face Climate change in Sub-Saharan Africa: Mangrove for Carbon Sequestration in Benin (West Africa)

Sh. Totin Vodounou (1) ; R. Babatoussou (1) ; E. Amoussou (2) ; M. Boko (3) ; A. Akongnou (4)
(1) University of Parakou, Geography, Parakou, Benin; (2) University of Parakou, Geography, Parakou, Benin; (3) University of Abomey–Calavi, Geography, Abomey–Calavi, Benin; (4) University of Abomey–Calavi, Botanic, Abomey–Calavi, Benin

The increase of carbon dioxide (CO2) in atmosphere and global warming are becoming a global challenge especially in Africa where adaptation capacity is low. Natural ecosystems as the green forests are known to contribute in controlling of the greenhouse gas through carbon sequestration. Across the world, mangrove forest is interested many studies which reveal the potential role of this ecosystem on climate change strategies. This study aims to strength how to use the mangrove ecosystem to face climate change through its capacity of carbon sequestration in Benin.

The study is based on existing literature, mangrove cover estimation from 1980 to 2040 in Benin, assessment of mangrove ecosystem capacity to sequester carbon in Benin based on critical, intermediate and optimistic scenarios. On the over hand, climate data such as temperature over the period 1961–2014 are analysed to correlate its trend in Benin to the global warming.

In Benin projections show an increase in air temperatures in all regions of Benin around 2100, with the largest increase in temperature, compared to the reference period 1971–2000, of around 3.2°C. In the same time, total greenhouse gas increased from 4797.74 Gg CO2-e to 6251.03 Gg CO2-e representing a growth of 30.29 % over the period 1995–2000. With regard to the principle of the Clean Development Mechanism and to adapt efficiently to this climate change in Benin, mangrove ecosystem can be useful. So carbon sequestration by mangrove in Benin is approximately estimated average of 24 169 t/yr in 2010 and 3580 t/yr in the critical scenario, 17 004 t/yr in the intermediate scenario and 35 423 t/yr in the optimism scenario at the horizon 2040. Promote mangrove ecosystem protection and development will help increase carbon sequestration in West Africa. So the great need is to enhance local community’s capacity on climate change adaptation using mangrove forest to control CO2 emissions based on reforestation, reinforcement of traditional law used for natural resources protection, implementation of Clean Development Mechanism (CDM) projects in Sub–Saharan Africa.
3332 - Asia on the Frontlines: Projected Impacts, Vulnerability and Adaptation

**ORAL PRESENTATIONS**

**K-3332-01**

**Projected Climate Change Impacts on Terrestrial Ecosystems of the Asian Highlands**

R. Zomer (1)
(1) World Agroforestry Center, Center for Mountain Ecosystems Studies, Kunming, Yunnan, China

Rapidly accelerating climate change in the mountains of Asia, notably the Himalaya, Hindu Kush, Tien Shan, and the Tibetan Plateau, is projected to have major implications for montane species, ecosystems, and mountain farming and pastoral systems. A geospatial modeling approach based on a global environmental stratification and a simple in situ water balance model has been used to explore potential impacts of projected climate change on the hydrology and spatial distribution of bioclimatic strata, across the Asian highlands. Projected climate change impacts on terrestrial ecosystems, including agricultural and pastoral systems, were modeled based on an ensemble of 19 Earth System Models (GCMs) across four Representative Concentration Pathways (RCP). Large and substantial shifts in bioclimatic conditions can be expected throughout the region by the year 2050, across all bioclimatic zones and ecoregions. Potential impacts include upward shift in mean elevation of bioclimatic zones, decreases in area of the highest elevation biomes and ecoregions, large expansion of the lower tropical and sub-tropical zones and ecoregions, and the shifting or disappearance of specific sets of bioclimatic conditions, threats to agricultural crop species, cropping systems, and genetic resources, the effectiveness of protected areas, and the rapid onset of potentially high levels of biotic perturbation by 2050, with a high likelihood of major consequences for biodiversity, ecosystems, ecosystem services, conservation efforts and sustainable development policies across the region. The importance of improved understanding of the direction and magnitude of climatic change for strategic planning, adaptation, and disaster response, is illustrated with case studies of landscape analyses and participatory community based approaches from Nepal, Pakistan, and southwest China.

**K-3332-02**

**Response to Climatic Hazard: Vulnerability Measurement of the Coastal People Matters**

M. Hossain (1)
(1) Griffith University, International Business and Asian Studies, Nathan, QLD, Australia

In recent years, climatic hazards – extreme weather conditions and rising sea-level – have impacted seriously on economies and daily life in many coastal regions. The present study measures the vulnerability of frontline coastal regions in order to find pathways for speedy recovery from the socio-economic devastation associated with climatic disasters, and to recommend potential protection measures for coastal people. The study focuses on two vulnerable regions of the Bay of Bengal delta. The outcome of this research will help understand the responses required after a climatic disaster. Governments, NGOs and international communities including Asian vulnerable regions need micro level studies, such as this, on which to develop effective sustainable development policies. The study uses survey data to investigate vulnerability following a recent climatic hazard (cyclone) that has affected Bay of Bengal delta in 2009. More specifically the aims are: 1. to investigate the impacts on socio-economic vulnerability due to climatic hazards in selected regions; 2. to find pathways for speedy recovery from the socio-economic devastation; and, 3. to recommend protection measures for the coastal people frequently hit by global warming induced climatic hazards.

It is not only a lack of knowledge on the risks from climatic hazards in developing Asia, in other OECD nations policy makers suffer from this knowledge gap. Being a closest neighbour of Asia, it is needed to know how much, for example, Australia spends on climatic change policies more than the immediate disaster aid to the victims? Does Australia take climate refugees? Immediate relief while important, it is also needed to know how well the affected regions cope from a natural calamity? There is, therefore, a serious need for showing results from small-scale micro studies that can develop a theoretical, methodological and empirical foundation to inform climate change adaptation/recovery options for households, governments and communities in front line regions.

The present research has been focused on assessing local level socioeconomic vulnerability of communities living in vulnerable locations of Asia. Vulnerability to climate disasters is a complex concept which has major socioeconomic and political implications. Public policies, including adaptation strategies, disaster risk reduction (DRR), and migration policies have the potential to play a determining role in addressing vulnerability. This paper is based on two villages surveyed from two sides of the Sundarbans on the Bay of Bengal delta and estimates the vulnerability of the coastal people from a category 5 Cyclone called ‘Aila’ hit in 2009. The villages are located in Barisal and Khulna district in Bangladesh and Jhalokathi and South 24 Parganas in West Bengal. A census of the entire households of the two villages has been carried out in 2011 and 2012. Vulnerability due to natural hazard has been investigated based on socioeconomic attributes of respondents. This vulnerability level is essential with a view to develop relevant adaptation policies for the Sundarbans region.

**O-3332-01**

**Climatic Change and Indian Agriculture – A Case Study of West Bengal**

R. Chakrabarty (1) ; S. Chakrabarty (1) ; CS. Lahiri (1)
(1) University of Calcutta, Business Management, Kolkata, West Bengal, India

The recent IPCC report (IPCC 2007) and a few other global studies indicate a probability of 10 to 40% loss in crop production in India with increase in temperature by 2080 – 2100. A few Indian studies on this theme generally confirm an agricultural decline with climate change. Recent studies done at the Indian Agricultural Research Institute indicate the possibility of a loss of 4 to 5 million tons in wheat production in future with every 1°C rise in temperature.

In this paper we have focused on the impacts of climatic change on agriculture faced by West Bengal. West Bengal is a state of India, which extends from Himalayas in the north and Bay of Bengal in the south. In 1981–82, West Bengal was amongst the lowest in the country with its per capita net agricultural product being 18 per cent lower than the national average. By 1994–95, it was above the national average by about 10 per cent.

Like all natural system, agriculture is linked to climate and there is some observed and projected climatic change in West Bengal also. During 1969–2005, a net warming trend has been established in the annual average temperature.

This paper studies whether the relationship between the long term Agricultural Production of India and West Bengal is trend stationary or not. This has been done by using Unit Root technique. It also studies the relationship between temperature and agricultural production. The paper then derives the relation between the GDP and Indian Agriculture Production on one hand and the SDP and West Bengal Agriculture Production on the other hand. This has been compared by using the Co-integration equations.

An in-depth survey has been conducted in six districts of West Bengal and the production of staple crops, rice and potato have been considered. We have carried out mean tests to compare the climatic change in the districts and also with a north Indian state. On the basis of the data long term projection has been made. Finally, the paper hints at considerable policy implications towards adaptation to climatic change in the state.
Mountains and the Anthropocene

J. Xu (1)
(1) Kunming Institute of Botany, Chinese Academy of Sciences, Kunming, Yunnan, France

Mountains change due to volcanic activity or rising tectonic plates; human activity, too, has changed mountains since the beginning of days. The extent and pace of anthropogenic changes to the mountain’s climate, cryosphere and biosphere are now so great that ecosystems and societies become unbounded, while the changes themselves become harder to predict and harder to live with.

In the mountains, geography promotes cultural diversity in languages, belief systems, architecture, settlement patterns and livelihood practices. Mountains are the cradles of many civilizations. People have adapted in ways that demonstrate their intimate relationship with the environment and knowledge about not only plants, wildlife, vegetation, and ecosystems, but also the risks and natural hazards such as earthquake, landslides, droughts and flash floods.

The seeds of "good Anthropocene" – positive visions of futures that are socially and ecologically desirable, just, and sustainable – can be observed in many cultural communities in mountainous regions. However, both practices and livelihoods are learning from natural disasters to adapt and local visualization to solicit, explore and develop a suite of alternative pathways for conservation and sustainable development in southwest China’s mountainous regions.

Farmer’s perceptions of and adaptations to changing climate in the Melamchi River Valley of Nepal

D. Schmidt-Vogt (1); S. Nani Maya (1)
(1) Kunming Institute of Botany, Kunming, China

Climate change is a global challenge that has a particularly strong effect on mountainous countries such as Nepal. 2005-2009, adaptive capacity is low and where agriculture, which is highly dependent on climatic factors, is the main source of total income and food consumption at household level. Among the biggest challenges to farming communities in future will be adaptation to climate change. As climate impacts are often locally specific, it is essential that large-scale initiatives to support farmers consider local priorities and integrate lessons from local adaptation efforts. There is limited knowledge and information available on how specific climate hazards impact livelihoods, and how farmer communities in the mountains of Nepal are responding to climate change. In addition most of the climate change projections using empirical models are unable to capture the local level specification of climate change. Therefore, knowledge of farmers’ perceptions of climate change and of their adaptation measure is important to enhance policies addressing the threat of climate change to farmers.

This case study examined farmers’ perceptions of and adaptations to changing climate in the Melamchi River Valley of Nepal. We surveyed 365 farmer households in six focus group discussions using a Community-based Risk Screening Tool – Adaptation and Livelihoods (CRIStAL) to understand local perceptions of and current adaptation practices to climate changes. Climate trends in the study area were analyzed for the period 1970-2000. Results show that while mean annual temperatures had risen by 0.18° and 0.9°C per decade during the 1980s and 1990s, respectively, the rise in temperature had accelerated to 1.56°C per decade after 2000. The frequency of drought had also increased measurably after 2003. With this change in climatic factors farmers observed increases in crop pests, hailstorms, landslides, floods, as well as thunderstorms and erratic precipitation as climate-related hazards affecting agriculture. Changing farming practices, selling livestock and livestock products, engaging in daily wage labor and seasonal migration were commonly practiced in response to climate change. Diversification of agriculture, improvement of current agroforestry practices, and investment in water-based income-generating opportunities were identified as means of adapting to climate changes.

Coastal Adaptation to Climate Change in Bangladesh: Challenges and Opportunities for Integrated Legal and Policy Responses

S. Alam (1)
(1) Macquarie University, Law, NSW, Sydney, Australia

The coastal area of Bangladesh comprises the second largest delta of the world. This coastal area comprises distinctive development opportunities which can be instrumental in reducing poverty and contributing significantly to the development of Bangladesh. Over the past few decades, however, the region has experienced threat from climate change, and the effects are now starting to be felt. Moreover, unplanned and disorganized coastal adaptation programmes and the absence of climate change considerations in the coastal planning are deteriorating the whole scenario. In response to the challenges posed by the effects of climate change, Bangladesh has adopted a number of adaptation measures, including the Bangladesh Climate Change Strategy and Action Plan 2005 and the Country Framework to Mainstream Climate Risk Management and Adaptation 2006. However, no laws and policies have been developed to date targeting specifically the development of coastal areas in the context of climate change. Moreover, the people living in the coastal area of Bangladesh are not adequately consulted and integrated both in policy making and implementation of disaster risk management plans and adaptation strategies. Bangladesh can enhance its coastal management by strategically integrating climate change adaptation, disaster risk management and development into its laws and policies.

In this context, this paper provides an assessment of impacts of climate change in the coastal zones of Bangladesh. It also examines the existing adaptation strategies and policies of the government. With a critical analysis of the provisions for adaptation strategies in the international climate change regime, it outlines the necessity for new adaptation strategies and policies in the context of the daunting challenges posed by climate change to the prospects of development in Bangladesh. This paper emphasises the importance of an integrated approach combining both disaster risk management and climate change adaptation in policy making in order to ensure climate resilient and climate compatible development in the coastal areas of Bangladesh. It further advocates for developing community-based adaption arguing that the empowerment of coastal communities will be more effective. Arguing that the communities themselves can identify and prioritise their risks, plan for mitigation and treat their risk factors. Ultimately communities should have direct access to and control over the public resources allocated for them and establish their rights to reduce their risks, be it social, cultural or political, and policy development process.
Mitigation & Adaptation experiences of farmers to drought in Semi-arid region of India

B. Nagaraja (1), B. Krishnakanth, (2)
(1) Bangalore University, Environmental Sciences, Bangalore, Karnataka, India; (2) Bangalore university, Environmental sciences, Bangalore, India

Climate change is predicted to have severe consequences on agriculture and the rural poor in South Asia and Africa. Given that approximately three-fifths of the cultivated area in South Asia is rain-fed, the onset, duration, spatial extent, and severity of such events are critical. Many factors are responsible for determining the livelihoods of large majority of people in rural areas. The arid regions of India cover an area of 317,090 km² and is exclusively dependent on rain-fed cultivation. About 40% of total rainfall occurs during the period from July to October. Frequent and prolonged droughts, caused by variations in timing and amount of rainfall, often result in intensive crop failures. These are also associated with increased poverty levels in the region. The present study documented traditional mitigation and adaptation measures in the region.

The drought affected regions of Karnataka recorded lower crop yields and consequent increased poverty levels in the region. The repeated droughts have led to over-exploitation of ground water bodies increased input requirements in rainfed areas and semi-arid regions. The two districts of Karnataka (Raichur and Koppal) each belonging to severely affected categories and representing arid climatic condition. The drought affected regions of Karnataka recorded lower crop yields and consequently increased poverty levels in the region. The repeated droughts have led to over-exploitation of ground water bodies increased input requirements in rainfed areas and semi-arid regions. The National Mission for Sustainable Agriculture speaks of attaining "ecologically Sustainable Agricultural Growth through progressive Adaptation and Mitigation. While the noises are sound, the mission still emphasizes the role of bio-technology. Whereas bio-technology options tend to be patented means of extracting rents out of the system. The complex and multidimensional nature of drought in India requires a long term, well organized and coordinated research in all and action involving all the stakeholders. The present study aims to highlight the ongoing efforts of farmers groups, government and Non-government organization in evolving ecosystem-based mitigation and adaptations strategies for the region.

Measuring Vulnerability of a region in Indonesia

Y. Tjoe (1)
(1) Griffith University, International Business and Asian Studies, Brisbane, Queensland, Australia

For many rural households in Indonesia, yields from subsistence production are the main source of food to maintain their health and livelihood. The livelihoods of households in dryland West Timor are expected to be affected by climate change due to their dependence on rainwater for their subsistence production. Due to the subsequent poor rainfall and low crop yield, some of the households have begun to adapt to broader modern employment and modified their income sources with males taking up external cash-employment; such as temporary labour in the construction or plantation fields at local cities or overseas. Is this pathway of income adaptation sustainable, compared to the subsistence-based corn farming and traditional forms of livelihood?

This paper investigates factors that contribute to the livelihood vulnerability of the subsistence households to drought. The five major factors include EDU (Education), SSC (Social-Cultural participation), FS (Food store), IA (Income through management of agricultural production) and ACC (Access). Primary data are collected through a household survey conducted in three villages of West Timor (total sample 627). Data gathered are then used to produce a vulnerability index, using the following equation:

\[ LVI_v = WeDU + WSCP + WSF + WIA + WACC \]

where:
- \( LVI_v \) = Livelihood Vulnerability Index for village \( v \)
- \( WeDU \) = weight of each major components (e.g. \( WeDU \) is the average value of major component)
- \( WSCP \) = weight of each major components
- \( WIA \) = weight of each major components
- \( WACC \) = weight of each major components

The Probit analysis is then performed to investigate the relationship between perceptions of households about causes of drought and their readiness to better equip themselves for the future drought or other disasters.

Where Cause_1i is type of cause: 'It has been like this all the time' = 1; otherwise = 0

Cause_2i is type of cause: 'I don't know why' = 1; otherwise = 0

Cause_3i is type of cause: 'God's Plan' = 1; otherwise = 0

Cause_4i is type of cause: 'Manmade' = 1; otherwise = 0

The case studies in semi-arid region of Karnataka offer a valuable complement to the macro profile by revealing insights on the determinants of vulnerability at the individual or community levels. Numerous physical and socio-economic factors come into play in enhancing or constraining the current capacity of farmers to cope with adverse changes. Prominent among the physical factors are cropping patterns, crop diversification, and shifts to drought-resistant varieties. The most important socio-economic factors include membership of agricultural cooperative (land, cattle, pump-sets, and agricultural implements), access to services (like banking, health, and education), and infrastructural support (like irrigation, markets, and transportation networks). From the last few decades, a growing incidence of seasonal migration is occurring in northern part of Karnataka due to the lack of livelihoods and fodder availability.
Statistical reliability and validity, and factor analysis are conducted using SPSS 22.

The results show that ACC (access to water, local market and health centre), SCP (social and cultural activities), and IA (income through management of agricultural production) are all significantly correlated with a household’s vulnerability to drought. Households are less vulnerable when they have better access, agricultural incomes, and when they and their children are actively involved in local agricultural and ritual activities. A poorer access to market and schools may also contribute to increasing household’s vulnerability as the youth have to leave the village and stay at urban area for employment or education purposes.

Combining all five factors, the overall vulnerability index for individual village shows that the further the village is to urban area (Kupang or Soe) the more vulnerability it is. The furthest village has the highest score (0.503), while the closest village scores 0.234.

Furthermore, the results of Probit analysis show that the tendency to take precautionary measures to anticipate drought and other disasters is related to the perception of the cause of disasters. Households tend to have no planned alternatives such as saving money or preparing water storage in the house when they believe that Gold’s plan or manmade are the cause of drought and other disasters.

The paper concludes that the temporary participation in broader modern employment may be an alternative for the households to cope with short-term impacts of drought and low crop yield. However, the social-cultural participation, which maintains local ritual and belief, provides long-term sustainable pathway for dryland ecosystem as it helps to regenerate local knowledge system and conserve the use of natural resources. Future adaptation should aim to increase household awareness of the importance of proactive saving (water and money), and to improve infrastructures that help sustain both existing economic and social-cultural activities.

**P-3332-04**

Local practices of reducing vulnerability, and securing livelihoods in the age of climate change: Lesson learned from the analysis of community adaptation plans and practices in Nepal

**DR. Uprety (1)**

(1) Multi Stakeholder Forestry Programme (MSFP), Climate change and Forestry, Kathmandu, Nepal

About 25% of the total populations in Nepal live under the poverty line (less than 1.25USD/day) and the country is ranked one of the 5th climate vulnerable countries around the world. Flash floods and landslides, loss of biodiversity, decrease in agricultural productivity, loss of forest species and depletion of fresh water resources are some major vulnerabilities resulted from the climate change and pushing the lives and livelihoods of over 1.9 million households at risk. Responding to these climates induced adversities, the local communities have started making their adaptation plans (more than 1500) in partnership with growing development institutions at local level. The paper is based on the studies of more than 1000 local adaptation plans, field observation and interaction with more than 500 communities in between 2011 to 2015. The paper analyses of the major vulnerabilities identified in different adaptation plans, local practices of responding these vulnerabilities, tradeoff between growing vulnerabilities, and securing livelihoods challenges through the analysis of the 1000 community adaptation plans in Nepal.

**K-3333-02**

The Economic Benefits of Decarbonization for China

**F. Teng (1)**

(1) Tsinghua University, Institute of energy, environment and economy, Beijing, China

China needs to reduce its carbon emissions if global climate change mitigation is to succeed. Conventional economic analysis views cutting emissions as a cost, creating a collective action problem. However, decarbonization can improve productivity and provide co-benefits that accord with multiple national policy objectives. Investment in greater energy productivity and economic restructuring away from heavy industries can bring productivity gains, and decarbonization of energy supply has important co-benefits for air pollution and energy security. To properly identify the true costs and benefits of climate change action requires robust economic analysis. This presentation draws on recent academic papers as well as research contributions to the New Climate Economy report and the global Deep Decarbonization Pathways project.
Low-carbon innovation in China: prospects, politics and practices
S. Geall (1) ; A. Ely (2)
(1) University of Sussex, Science Policy Research Unit, Brighton, United Kingdom; (2) STEPS Centre, SPRU – Science Policy Research Unit, Sussex, United Kingdom

This paper explores innovation in China and its potential to contribute to global transitions to low-carbon patterns of development. Building on earlier studies bringing alternative forms of low(er)-technology, ‘below-the-radar’, ‘disruptive’ and social aspects into innovation, and drawing on empirical research on electric mobility, solar-generated energy and food systems in China, the paper also pays particular attention to issues of changing power relations and political practices. Taken together, this shift in perspective allows neglected questions in low-carbon innovation to be introduced and points to both opportunities and challenges to low-carbon system transition that are overlooked by an orthodox focus on technological innovations alone.

Intersections of China’s Energy Technology Innovation, S&T Policies and Ongoing Reform
J. Fan (1)
(1) International Energy Agency, Paris, France

China’s energy technology innovation, with a strong focus on clean energy technologies, is central to a strategy that faces head-on the dual challenge of satisfying energy demands while safeguarding the environment as part of China’s so-called ‘Energy Revolution’. Combining, with the global concern on addressing climate change, China’s policies and actions in energy field have been focused on industrial transformation, energy system overhauls, energy efficiency promotion and the environmental protection. Recent energy technology innovation, S&T policies and reforms seek to capture opportunities for economic advantage from the transition to cleaner and more sustainable and increasingly market-oriented system.

China has demonstrated some progress in its low-carbon and energy sector development. The remarkable progress proceeded in China in aims of offering greater information transparency and openness to promote innovation. A new round of energy and S&T policies.

State R&D fund acts as one of the most important financing channels for energy technology innovation. China’s funding for research and technology (R&D) as share of GDP (R&D intensity) is increasing, but unprecedented co-ordination among government and institutional actors will be needed to sustain innovation over the long term. Early discussions should also consider opportunities for institutional reform to promote innovation. A new round of S&T reform is being proceeded in China in aims of offering greater information disclosure and transparency and promoting the efficiency of resource allocation.

The commercialization of technology is another key issue requiring efforts to enhance China’s innovation competitiveness. Enforcing IP governance and encouraging the development of public–private partnerships (PPPs) to support innovative approaches to new market have been emphasized by the government.

Monitoring and evaluating innovation measures against energy sector and environmental benefits can help to improve policy implementation over time and lead to more effective innovation systems designed to meet the main public objectives. The effects of China’s ongoing reform in the field of energy and S&T are worth a further observation.

The transportation sector as a lever for reducing long-term Chinese mitigation costs
M. Hamdi-Cherif (1)
(1) CIRED, Nogent-sur-Marne, France

** Rationale and Objective: Chinese economic development goes hand in hand with (i) a growth of the production that is accompanied with an increase of the freight transport, and (ii) an enriched population and fast-growing urbanization that induce increasing demand for passenger transport (notably an increase of the motorization rate). Given that China has to redouble its efforts with voluntary schemes promoting mobility growth control. This paper investigates the role of passenger and freight transportation activities in the transition to a low carbon Chinese economy. A particular attention is given to specific measures designed to control the growth of mobility. It is an attempt to quantify the impact of urban voluntary policies on Chinese mitigation costs.

** Modeling approach and Methodology: This article revisits the role of the transportation sector in low-carbon pathways by using the Energy-Economy-Environment (ENE) model IMACLIM-R. It is a hybrid multi-sector CGE model, which embarks a detailed description of passenger and freight transportation. The standard representation of transport technologies is supplemented by explicit representation of the behavioral determinants of mobility. The model relies on hybrid matrices ensuring consistency between money flows and physical quantities and allows an explicit representation of the trade-offs between mobility and environmental effects. It accounts for the rebound effect of energy efficiency improvements on mobility, endogenous mode choices in relation with infrastructure availability, the impact of investments in infrastructure capacity on the amount of travel, and the constraints imposed on mobility needs by firms’ and households’ location.

Moreover, IMACLIM-R represents the second best nature of economic interactions and the inertias on technical systems that limit the flexibility of adjustments, a crucial dimension for designing economies when envisaging large structural change over the course of the century.

Complementarily to carbon pricing to reach stringent climate objectives (3.4W/m2 in 2100), we explore actions to control the “behavioral” determinants of transportation in the course of the low-carbon transition, and assess their effects on the Chinese economy. More specifically, we consider (i) urban reorganization lowering the constrained mobility (i.e. mobility for commuting and shopping), (ii) reallocation of investments in favor of public modes at constant total amount for transportation infrastructure and (iii) adjustments of the logistics organizations to decrease the transport intensity of production/distribution processes.

** Results: This analysis demonstrates the risk of high losses if using carbon price as the sole instrument of mitigation. Transport proves to be the sector for which carbon emissions are the more difficult to reduce. It thus represents a dominant share of remaining emissions in the long-term when ambitious mitigation objectives are set. Because of its weak reactivity to price increases, very high levels of carbon prices are needed in the second half of the century to reach low-carbon development, if we consider that they can reach 1400$/tCO2 by the end of the century.

But we find that controlling mobility growth allows limiting these effects by offering mitigation potentials independent of carbon prices. The considered measures allow significant reductions of carbon price levels (on average 25% lower over 2050–2100) and hence help limiting the macroeconomic costs of the mitigation policies (e.g. long-term mitigation costs are reduced by 5 points in 2050 and
In this paper we investigate energy technology deployment under climate change mitigation efforts in Latin America. Through several carbon tax and CO2 abatement scenarios we analyse what technologies in the energy sector, and particularly electricity generation, could best be used until 2050 to significantly reduce CO2 emissions in the region. By way of sensitivity test we perform a cross-model comparison analysis and inspect whether robust conclusions can be drawn across results from not only different models, but also different types of models (that is, bottom-up versus top-down, and general equilibrium versus partial equilibrium models). Given the abundance of biomass resources in Latin America, they are likely to play a large role in energy supply in all the scenarios we inspect, especially in the climate policy scenarios since some use of biomass can be combined with CCS. We find that hydropower, which today already contributes about 80% of overall power production in the region, could be significantly expanded to meet the climate policies we investigate, on average by 50% but perhaps by as much as 75%. According to all models, electricity generation will increase exponentially with a two–to three-fold expansion between 2010 and 2050. We find that renewables such as wind and solar power typically expand at double-digit growth rates, but the robustness of our findings differs substantially between these two options: the climate policies represented in our models raise wind power in 2050 on average to half the production level that hydropower supplies at present, depending on which model is used. For CCS we also observe a large diversity in model outcomes, which reflects the uncertainties with regard to technological implementation potential given that challenges this CO2 abatement technology currently faces.

The extent to which different mitigation options can be used in practice varies a lot between countries within Latin America, depending on factors such as resource potentials, economic performance, environmental impacts, and availability of technical expertise. We provide concise assessments of possible deployment opportunities for some low-carbon energy options, mostly for the region at large but with some country-level detail in specific cases. A similar climate scenario study of technology diffusion in Latin America has not yet been made, so we contribute a piece of work to the existing literature. This study possesses particular relevance for the ongoing climate negotiations leading up to COP–21 in Paris, as was demonstrated by the attention we received by the presentation of this work during COP–20 in Lima in December 2014. Given the theme of this paper, our work, if accepted, could best be presented in session.

K-3335-02
Climate Change Mitigation in Latin America

T. Kober (1); B. Van Der Zwaan (2)
(1) Energy research Centre on the Netherlands, Policy Studies, Amsterdam, Netherlands; (2) University of Amsterdam, Faculty of science, Amsterdam, Netherlands

In this keynote speech we present an overview of today’s structure of the energy sector of Latin America and provide a long-term outlook of possible future developments towards low-carbon modes and a decoupling of mobility needs from economic activity prove to modify the sectoral distribution of mitigation efforts and to significantly reduce the mitigation macro-economic costs relatively to a ‘carbon price only’ policy.

Before highlighting climate change mitigation in Latin America, we discuss the baseline projections for the set of models participating in the CLIMACAP–LAMP project and identify key differences between model projections in this regard. These can be grouped into structural and trend-related differences. We find that population and GDP projections across models span a broad range, comparable to the range represented by the set of Shared Socioeconomic Pathways. Kaya-factor decomposition indicates that the set of baseline scenarios mirrors trends experienced over the past decades. Emissions in Latin America are projected to rise as result of GDP and population growth and a minor shift in the energy mix towards fossil fuels. For the future most models assume a somewhat higher GDP growth than historically observed and continued decline of population growth. We observe minor changes in energy intensity or energy mix are projected over the next few decades.

The climate policy scenarios perform around three main clusters of policy measures: carbon taxes, greenhouse gas certificates to attain different levels of temperature stabilization. Regarding the latter, we explicitly investigate pathways reach a stabilization of the mean temperature increase at 2°C compared to pre-industrial level. We find that an overall energy emissions reduction of roughly 50% across Latin America is consistent with meeting a 2°C goal at lowest cost. However, a range of other mitigation levels will also be consistent with meeting this goal. Our study confirms the results of previous research that the variations in mitigation outcomes across models may vary by as much as an order of magnitude. For Latin America as a whole, currently discussed country level policies lower 2030 emissions to a level that are not inconsistent with a 2°C target. Besides greenhouse gas emission reduction potential related to energy conversion, avoidance of land use and land use change emissions will play an pivotal role, particularly for Colombia and Brazil. These emissions will be alternatively affected by efforts to store more carbon in land and those aimed at producing more bioenergy for low-carbon energy.

One of the major economies in Latin America is Brazil for which our results show an increase over time in emissions in baseline scenarios due, largely, to higher penetration of natural gas and coal. However, the policy scenarios, however, do not indicate that such a pathway can be avoided. While carbon taxes up to 32 US$/tCO2e do not significantly reduce emissions, higher taxes (from 50 US$/tCO2e in 2020 to 62 US$/tCO2e in 2050) induce average emissions reductions around 60% when compared to baseline. Emission constraint scenarios yield even lower reductions in most models. Emission reductions are mostly based on onshore renewable energy (especially biomass and wind) and of carbon capture and storage technologies for fossil and/or biomass fuels. The range of mitigation options resulting from the model runs generally fall within the limits found for specific energy sources in the countries, although infrastructure investments and technology improvements are needed for the projected mitigation scenarios to achieve actual feasibility.
O-3335-01

The macroeconomic impact of climate mitigation action in Latin America: a model comparison

P. Summerton (1)

(1) Cambridge Econometrics, Cambridge, United Kingdom

In this paper we investigate economic impacts under climate change mitigation efforts in Latin America. Through several carbon tax scenarios we analyse the impact that climate change mitigation policy might have on income, trade and investment in the region. By way of sensitivity tests to the price path a cross-mapping comparison analysis and inspect whether robust conclusions can be drawn across results from not only different models but also different types of modelling approach (that is, a hybrid modelling approach and dedicated energy system models, TIA-M-ECN, with a macro-simulation modelling, E3ME, compared to the mainstream general equilibrium modelling approach).

The paper presents the first detailed multi-model comparison of the macroeconomic consequences of carbon pricing action in Latin America. In the short term at carbon prices reaching around $15/tonne of CO2 by 2030 the models agree that the reduction in consumer spending, as a proxy for welfare, is expected to be limited in all countries modelled and across the continent. However, by 2050 and at carbon prices of $165/tonne of CO2, there is much more divergence in the estimated impact on GDP and consumer spending across models and across countries in Latin America reflecting the uncertainty about the costs of technology and substitution between technology options. The insight of the hybrid modelling approach comes through in the comparison of increasingly higher carbon prices in each model. The negative impact of reduced consumer spending and GDP are linear in the CGE models and increase as the carbon price increases; but divergent and non-linear in E3ME-TIAM-ECN reflecting step-changes in technology substitution in TIAM-ECN and the non-linear impact of each technology (its cost, cost composition and supply chain implications) on the economy as represented in E3ME.

A similar multi-model scenario analysis of economic impacts of mitigation policy in Latin America has not yet been made, so we contribute a new piece of work to the existing literature. This study possesses particular relevance for the ongoing climate negotiations leading up to COP-21 in Paris, as was demonstrated by the attention we received by the presentation of this work during COP-21 in Lima in December 2014. Given this context of this paper, our work will hopefully best be presented in session N° 3335 – Latin America pathways. This has been a multi-authored exercise, led by Philip Summerton, with contributions from Hector Pacheco (Cambridge Econometrics), Unnada Chiewpricha (Cambridge Econometrics), Xiaolin Ren (National Centre for Atmospheric Research), William Wills (Energy Planning Program, Pontifical University of Rio de Janeiro), Claudia Orrego (MIT Joint Program on the Science and Global Change), James McFarland (US Environmental Protection Agency), Robert Beach (RTI International), Andres Camilo Alvare Espinosa (National Planning Department, Colombia), Silvia Calderon (National Planning Department, Colombia), Karen Fisher-Vanden (Penn State University), Katie Daenzer (Penn State University), and Ana Maria Loboguerrero Rodriguez (CIAT–CCAFS).

O-3335-02

Scenario building and macroeconomic modeling in response to climate change challenges: an overview of the modeling results from MAPS Latin America

AM. Rojas (1)

(1) University of Cape Town – MAPS Programme, Energy Research Centre, Cape Town, South Africa

The Mitigation Action Plans and Scenarios (MAPS) programme is a collaboration amongst developing countries to establish the evidence base for long-term transition to robust economies that are carbon efficient and climate resilient. The programme aims to contribute to ambitious climate change mitigation aligned with economic development. Central to MAPS is the way it combines research and stakeholder interest with policy and planning, through providing robust research to underpin national policy processes. This paper focuses on the scenario building and macro-modelling experiences in each of the four MAPS Latin America countries: Brazil, Chile, Colombia and Peru.

The paper starts with a description of the results on national feasible GHG abatement options and mitigation options that were identified in each case. We then evaluate cross-cutting assumptions, most recurrent/common actions in the four countries and mitigation scenarios packaging criteria. Later, we compare Required by Science and Required Equity scenarios to the mitigation scenarios to assess ambition and equity levels in the four countries.

Next, the paper explains the economy-wide impacts associated to these mitigation options and scenarios. This section includes a summary of the macroeconomic modelling approaches key features and cross-cutting assumptions. This is followed by an analysis of the related impacts of these assumptions on the socio-economic indicators such as GDP, welfare and employment.

Through out the paper, benchmarks and indicators are calculated to evaluate the results.

This analysis draws on four unique Latin American country experiences that could inform and support policy makers in other Latin American countries when examining policy interventions to transition to a low carbon economy.

O-3335-03

Energy Supply Investments in Latin America under Climate Control Policy

J. Falzon (1) ; T. Kober (2) ; B. Van Der Zwaan (3) ; K. Calvin (4) ; A. Kanudia (5) ; A. Kitous, (6) ; M. Labriet (7)

(1) Energy Resarch Centre on the Netherlands (ECN), Policy Studies, Amsterdam, the Netherlands; (2) Cambridge Econometrics, (3) University of Amsterdam, Amsterdam, Netherlands; (4) ECN / University of Amsterdam, Amsterdam, Netherlands; (5) JCRF, Joint Global Change Research Institute, College Park, United States of America; (6) KanORS-EMR, NOIDA, UP, India; (6) DG JRC – European Commission, Institute for prospective technological studies, Seville, Spain; (7) Eneris Environment Energy Consultants, Madrid, Spain

In this conference contribution we present our findings on energy supply investment requirements in Latin America until 2050 investigated through a multi-model approach as previously applied in the MAPS Latin America programme. Key findings of the project have already been presented at COP 20 in Lima and are forthcoming in a dedicated special issue in Energy Economics expected in spring 2015. In our analysis, we can compare a business-as-usual scenario needed to satisfy anticipated future energy demand with a set of scenarios that significantly reduce CO2 emissions in the region. We find that more than a doubling of investments, in absolute terms, occurs in the business-as-usual scenario between 2010 and 2050, while investments may be multiplied by up to three over the same time horizon when climate policies are introduced. However, investment costs as share of GDP decline over time in the business-as-usual scenario, and even under the most ambitious climate policy scenario, due to the rapid economic growth in the region. For the electricity supply sector business-as-usual scenarios result in 1.4 trillion US$ are anticipated between 2010 and 2050, and become increasingly important when additional climate policies are introduced: under a carbon tax of 50 $/tonne of CO2 in 2020 increase in investment costs are multiplied by 1.3, an additional 0.6 trillion US$ (+45%) investment is needed. Further, our analysis suggests that compared to the business-as-usual case an additional 21 billion US$ per year electricity supply investments in Latin America until 2050 under a climate policy aiming at 2C climate stabilization, which, when compared to the 100 billion US$2020 targeted to be mobilized globally under the Copenhagen Accord across 2020-2030 period. In terms of specific low carbon electricity technologies, model results reveal that wind, solar, and CCS applied to fossil fuels and biomass will play an important role under climate policy scenarios. The results do not show significant investment opportunities in renewable energy exist in the short- to medium-term, even in the absence of climate policy measures. If climate change mitigation is envisaged policy frameworks with ambitious long-term goals provide
Quantifying the impact of non-conventional renewable energy sources in reducing greenhouse gas emissions: Chilean experience

C. Benavides (1)
(1) Energy Center, University of Chile, Santiago, Chile

The countries are interested in quantifying the impact of mitigation actions that they have implemented in order to know how far or near they are from meeting their voluntary and non-voluntary pledges. During COP19 in 2009, Chile proposed a voluntary commitment to reduce its GHG emission by 20% by 2020 with respect to 2007 baseline scenario. This commitment was confirmed in the Climate Summit in New York (2014) and during the COP21 in Lima, Peru (2014). In the case of Chile, the reason to select the year 2007 as a reference is because the country wants that the mitigation actions implemented before 2009 are recognized as a national mitigation effort. In Chile, one the main environment policies is the non-conventional renewable energy (nCre) law implemented before 2009. The first non-conventional renewable energy law was launched in 2008 and it stated that 10% of the total sales would be provided by nCre sources in 2025. This law states that 20% of the total sales would be provided by nCRE sources in 2025. This quota system was updated recently (2013) and the new law states that 20% of the total sales would be provided by nCRE sources in 2025. This paper aims to propose a methodological approach to quantify the impact of the non-conventional renewable energy law in reducing greenhouse gases emissions in Chile. The effectiveness of this policy is analyzed.

In order to quantify the impact of this mitigation action by 2020, this exercise requires projecting at least two scenarios: the baseline scenario, i.e. the GHG emission trajectory considering the implementation of the nCRE law and the counterfactual scenario. This is an estimate of what would have occurred in the absence of the nCRE law. The methodology used an optimization model in order to project the planning in new power plants in the power sector. This model also projects the electricity generation by power plants and the GHG emissions. The steps of methodology are the following:

1) A gathering information process is done for those nCRE projects installed between 2007 and 2014. The first step of the proposed methodology is to estimate how many of these projects were installed due to the nCRE policy launched in 2008.

2) Construction of periodical baseline scenarios between 2007 and 2013: The model to project the baseline scenario is run activating and not activating the nCRE constraint. The resulted investment plants of these cases (with and without nCRE constraints) are compared in order to estimate the installed capacity in nCRE projects between 2007 and 2013. This projection is compared to the real projects installed in the same period.

3) In order to project the emission reduction by 2020, a Baseline 2014 scenario is projected. The Baseline 2014 is the scenario which considers the current situation and trends of the electricity generation sector: current investment, cost optimization, future projection of demand, etc. This model is run activating the nCRE constraint (20% of sales will be provided by nCRE sources by 2025).

4) Projection of the counterfactual scenario since 2014: This scenario has two main differences in comparison to Baseline 2014 scenario. The first, this model is run non-activating the nCRE energy law, and the second, is to suppose that only x% of the installed capacity in nCRE project would be installed in 2014. This percentage is calculated from step 2 of the methodology. The Chilean voluntary pledge relates to a Baseline 2014 scenario; however, we propose that a more realistic quantification of the emission reduction of the policy is done using the current trends of the sector.

5) A sensitivity analysis is done in order to capture the uncertainties.

The results of this methodology show that the emission reduction of this policy would be between 1.1 and 6.1 million tCO2 in 2020. This emission reduction is compared to other policies implemented in Chile. The results show that the nCRE law has been the most important policy to mitigate the climate change. However, it has not been enough due to the building of thermoelectric power plants that has not stopped in Chile. In effect, between 2009 and 2013, 2263 MW of coal power plants were installed. In addition, there are 611 MW of coal plant under construction. Therefore, by 2016 will be 2874 MW additional in coal plant with respect 2006 installed capacity. It means that at least additional 28 million tCO2 will be launched to the atmosphere by the electricity generation sector.

The territorialization of climate change in southern rural Chile: linking local knowledge to global environmental change

G. Blanco-Wells (1); A. Lagarrigue, (2)
(1) Universidad Austral of Chile, Center for climate and research, Valdivia, Los Ríos, Chile; (2) Universidad Austral of Chile, Instituto de historia y ciencias sociales, Valdivia, Chile

This paper presents findings of a five-year research programme called the Sociology of Climate Change (sCC) carried out in southern Chile by an interdisciplinary team. By means of ethnographic work and extended case methods, the National Science, Technology and Innovation Council (CONICYT) developed a multidisciplinary programme called Chile’s National and international public policies on climate change are territorialized in rural regions of southern Chile by farmers, rural dwellers, scientist, and other local agents. From a social sciences perspective, climate change can be seen as an elusive techno-political object needing complex methods to be represented. However, it has gradually become a transforming driver of rural practices and everyday life in rural territories worldwide.

Therefore, the main focus of the case studies is to present evidence about how local actors internalized the socio-technical object called climate change creating new practices and meaningful representations of an otherwise distant global phenomenon. Most institutional actions by government, universities, and international organizations are loaded with a highly normative approach placing climate related problems but a process of understanding and engaging in new sustainable and/or transformative options.

The results show that local actors are concerned with climate change problems but a process of understanding and translation to local epistemologies and ontologies is needed, a process that we have conceptualized as territorialization. To illustrate this point we present specific findings on the associations between climate change and peasant agriculture on Chiloé Island, in southern Chile. Drawing from Actor-Network and Social Practice Theories, we track interesting changes in the use of local peasant knowledge as it relates to weather and the organization of farming activities. Furthermore, we find evidence concerning the configuration of new practices and processes devised to explore the means of facing the negative consequences of this phenomenon, in terms of both production, and the fragmentation of local knowledge.

The conclusions highlight the importance of empowering networks where mentioned responses are produced and diversified, and in which local knowledge can be updated and applied to the organization of rural practices in order to face growing climate variability.

3335-P-01

P-3335-02

The territorialization of climate change in southern rural Chile: linking local knowledge to global environmental change

G. Blanco-Wells (1); A. Lagarrigue, (2)
(1) Universidad Austral of Chile, Center for climate and research, Valdivia, Los Ríos, Chile; (2) Universidad Austral of Chile, Instituto de historia y ciencias sociales, Valdivia, Chile

This paper presents findings of a five-year research programme called the Sociology of Climate Change (sCC) carried out in southern Chile by an interdisciplinary team. By means of ethnographic work and extended case methods, the National Science, Technology and Innovation Council (CONICYT) developed a multidisciplinary programme called Chile’s National and international public policies on climate change are territorialized in rural regions of southern Chile by farmers, rural dwellers, scientist, and other local agents. From a social sciences perspective, climate change can be seen as an elusive techno-political object needing complex methods to be represented. However, it has gradually become a transforming driver of rural practices and everyday life in rural territories worldwide.

Therefore, the main focus of the case studies is to present evidence about how local actors internalized the socio-technical object called climate change creating new practices and meaningful representations of an otherwise distant global phenomenon. Most institutional actions by government, universities, and international organizations are loaded with a highly normative approach placing climate related problems but a process of understanding and engaging in new sustainable and/or transformative options.

The results show that local actors are concerned with climate change problems but a process of understanding and translation to local epistemologies and ontologies is needed, a process that we have conceptualized as territorialization. To illustrate this point we present specific findings on the associations between climate change and peasant agriculture on Chiloé Island, in southern Chile. Drawing from Actor-Network and Social Practice Theories, we track interesting changes in the use of local peasant knowledge as it relates to weather and the organization of farming activities. Furthermore, we find evidence concerning the configuration of new practices and processes devised to explore the means of facing the negative consequences of this phenomenon, in terms of both production, and the fragmentation of local knowledge.

The conclusions highlight the importance of empowering networks where mentioned responses are produced and diversified, and in which local knowledge can be updated and applied to the organization of rural practices in order to face growing climate variability.
Guatemalan Advances to climate change adaptation and Mitigation

M. Chacon (1)
(1) Doctoral Program Climate Change, San Carlos Guatemala University, Guatemala, Guatemala

The goal of this essay is to present a comparative review of the advances of Guatemalan national and municipal initiatives towards climate change adaptation and mitigation, which includes policies, programs and disciplines, in the local communities’ practices to make resilient communities. The author of this essay analyzes the limitations and contributions to climate change adaptation derived from the local and national policies to sustainable development with the complexity of poverty and climate change impacts. The author also describes private sector experiences in managing natural resources with environmental sustainability and strategies for sustainability and resilience. It is the case of millennial Mayan historical places like Tikal, and international most attractive and visited spots such as Atitlan Lake and Flores Lake where level of water degradation including deforestation, introduction of exotic species, and erosion; degradation of landscapes values, diminished environmental protected corridors, loss of integrity, loss of attractiveness. Moreover, other social economic impacts are the losing the investment of private housing and state investments in municipal parks located in lands occupied by the Mayan communities. Because climate change has shown strong effects in Central American countries in impoverished communities in societies where demographic institutions are recently in building process, in this essay the author of this essay has given special attention to national institutional capacities and economic development plans for in order to know the main principles and aspects that should have been considered in the process of making rural development programs related to the social, institutional, cultural, political and economic impacts of climate change effects in the indigenous communities most affected also by poverty. They are the impoverished urban and rural populations of Latin America which have had increased social economic vulnerability because of the climate change impacts. The climate change impact would be deepest since local governments and rural population have little or lack of understanding of the mid and long term climate change effects and strategies to adapt it to in local communities.

Therefore, it is very crucial to review the climate change factors and effects which are affecting communities not only because of atmospheric Nina and Nino phenomena, but also because of the environmental, social, political and economic impacts and constraints for climate change adaptation and sustainable development. Conversely, it is fundamental to the climate change effects with sustainability challenges such as poverty, population emigration to international labor such as in the construction industry, with environmental degradation including deforestation, introduction of areas with planting illegal cultivation related other drugs’ trafficking activities, rural land fragmentation, erosion; such factors are creating more complexity to democratic institutional capacities and economic development plans and strategies for sustainability and resilience. It is the case of the most attractive touristic spots in Guatemala where economic development derived from international tourism is jeopardized because the environmental degradation; it is the case of millennial Mayan historical places like Tikal, and international most attractive and visited spots such as Atitlan Lake and Flores Lake where level of water is increasing covering the parts of the surrounding towns. The impacts are more destructive in rural lands and towns because of land use location near risky places where there have been landslides and natural disasters such as Hurricane Stan Storm. Other impacts are the reduction of environmental values, ecological functions, landscapes values, diminished environmental protected corridors, loss of integrity, loss of attractiveness. Moreover, other social economic impacts are the losing the investment of private housing and state investments in municipal parks located in lands occupied by the Mayan communities. Because climate change has shown strong effects in Central American countries in impoverished communities in societies where demographic institutions are recently in building process, in this essay the author of this essay has given special attention to national institutional capacities and economic development plans for in order to know the main principles and aspects that should have been considered in the process of making rural development programs related to the social, institutional, cultural, political and economic impacts of climate change effects in the indigenous communities most affected also by poverty. They are the impoverished urban and rural populations of Latin America which have had increased social economic vulnerability because of the climate change impacts. The climate change impact would be deepest since local governments and rural population have little or lack of understanding of the mid and long term climate change effects and strategies to adapt it to in local communities.

Latin America: A Case Study in Nicaragua

D. Ponce De Leon Barido (1); D. Kammen (1); J. Johnston (2)
(1) University of California, Berkeley, The Energy and Resources Group, Berkeley, California, United States of America; (2) University of Hawaii, electrical engineering, Honolulu, United States of America

The global carbon emissions budget going forward depends critically on the choices made by fast-growing emerging economies. Yet there are few studies that develop country-specific energy system integration insights that can inform emerging economies in this decision-making process. High spatial- and temporal-resolution energy systems models are central to evaluating decarbonization scenarios, but obtaining the required data and models for such analysis can be cost prohibitive, especially for researchers in low and middle income economies. Recent research also highlights that although low-carbon economy transformations in emerging economies could prove challenging and expensive, cost-effective mitigation actions, such as fossil-fuel subsidy reform, decentralized modern energy access expansion, and fuel switching in the power sector, are not only possible, but feasible.

Nicaragua is a country whose power system, like others in Central America and the Caribbean, has been historically dependent on imported fuel oil. Most recently, however, and despite Nicaragua’s location in the Western Hemisphere, the country is leading a low-carbon power system transformation in Latin America. In 2013 it produced 40% of its electricity from non-hydro renewable energy and in 2014, 45% of its generation from wind power alone. Motivated by energy security, industrial development, financial risk mitigation, and the need for increased energy access to its most vulnerable populations, Nicaragua has transformed its energy sector in recent years. Between 2009 and 2014 it installed ~190MW of wind energy capacity (14% of total installed capacity), underwent an intensive geothermal technical capability training in partnership with the United States, and between 2006 and 2014 the country received over US$1.5bn of cumulative renewable energy investments. Yet, despite this great progress, Nicaragua’s own ambitious goals (70% and 93% renewables-based generation including large hydropower by 2017 and 2026, respectively) seem daunting. Here, we utilize both high-resolution open-access data and electric power system planning tools (SWITCH, an optimization model for planning power system investments and operations developed at the University of California, Berkeley) to demonstrate how low- and lower-middle income economies can develop optimal fuel-switching strategies and scenarios for a low-carbon grid. We choose Nicaragua for our analysis as it has very low electricity access (79%), oil accounts for over 85% of energy imports (over 85% of Nicaragua’s revenue goes towards covering this expenditure), and its current expansion plan (2014–2030) relies primarily on large hydropower development, making the power system particularly vulnerable to hydro-climatological variability. We evaluate eight power system planning scenarios (base case, geothermal and solar development mandates, oil and large hydro moratoriums, exogenous and risk mitigation) to identify optimal fuel-switching strategies across the country. We find that although low-carbon economy transformations in emerging economies can prove challenging and expensive, cost-effective mitigation actions, such as fossil-fuel subsidy reform, decentralized modern energy access expansion, and fuel switching in the power sector, are not only possible, but feasible.
ABSTRACT BOOK

3336 - Post-2030 decarbonisation pathways in Europe

ORAL PRESENTATIONS

K-3336-01

Title not communicated
A. Tilche (1)
(1) European Commission, DG Research & Innovation, Brussels, Belgium

Abstract not communicated

K-3336-02

Fifth Road Generation: Infrastructure integrated energy systems supporting the transition in the transport energy pool (Session number 3336 :Post-2030 decarbonisation pathways: the electricity and transport sector)

N. Hautière (1)
(1) IFSTTAR, Marne-la-vallée, Champs sur marne, France

The fight against global warming is a major challenge. In the transport sector, it means both the invention of a sustainable mobility for mitigating climate change, but also adapting infrastructure to the same climate change. Being the predominant mode of transport, the road is at the heart of these ecological transition issues, plus its own challenges such as road deaths or the upselling of the corresponding industrial sector.

In developing countries, according to the International Energy Agency (IEA), the number and extent of roads will expand dramatically this century. Globally, at least 25 million kilometers of new roads are anticipated by 2050, i.e. a 60% increase in the total length of roads over that in 2010. These new road infrastructures will have to face many important and diverse challenges, such as a strong increase of the land-use conflicts between transport infrastructures and agriculture.

In western countries, even if a shift to other modes of transport is wished for, the road still represents more than 80% of individual trips and of freight transport and the situation is not likely to change. Indeed, the road network has been developed over thousands of years: emerging from the track to the paved road, then to the smooth road and on to the continuous road.

Despite all the progress made in this sector, the environmental cost of current road infrastructures is still too important. There is thus a need of strong innovations in this sector to solve the related issues. Unfortunately, the road sector is experiencing difficulties to innovate. This is partly due in France to a lack of support from public authorities, like the lack of competitiveness cluster, or of an ambitious innovation program. This fragility is even more worrying, since a number of breakthrough innovations are emerging internationally. Among the most promising technologies, one can cite the green materials, the nanomaterials and nanosensors, the electromobility, the energy harvesting, and the cooperative intelligent transportation systems.

The RSG program (RSG for French “Route de 5ème Génération”) aims at changing the image of road infrastructures by designing, constructing and operating full scale demonstrators, which implement the innovative solutions, already tested in research centres. Aligned with the Forever Open Road program led by the Federation of European Highway Research Laboratories (FEHRL) since 2011, the program is elaborated in a systemic approach and is divided in three phases: labeling, appropriation and generalization. Among the seven technical challenges, the challenge of positive energy roads is currently debated in the framework of the French energy transition law and is likely to open new business models. The potential benefits of such a program are numerous: Maintaining the RAMS (Reliability, Availability, Maintainability and Safety) of existing road networks, reinforcing industrial leaderships and targeting societal objectives (education, employment, and environment).

O-3336-01

Investigation of carbon dioxide fluxes and possibility its storage in Georgia

M. George (1); M. Todadze (1)
(1) Institute of Geophysics, Ivane Javakhishvili Tbilisi State University, Tbilisi, Georgia

The major objective of investigation was study the natural CO2 sources, to investigate the properties of rocks, which contain and absorb CO2 during its emission. Mentioned rocks are considered as an underground Carbon dioxide reservoirs. For this case created numerical model to determine the potential of save sequestration in Carbon dioxide reservoirs and aquifers and to understand the geochemical and mechanical processes associated with long-term storage of CO2 including methods to assess zones of weakness. Finally was calculated balance of carbon dioxide and how it decreases emission in atmosphere in future.

3337 - Facing floods and climate challenges: designing governance arrangements and unlocking financing on the pathway to resilient cities

ORAL PRESENTATIONS

K-3337-01

Governance for resilient cities: insights from the STAR-FLOOD project

A. Crabbé (1); C. Larrue (2)
(1) University of Antwerp, Faculty of political and social sciences, Antwerp, Belgium; (2) Institut d’Urbanisme de Paris – Université Paris Est Créteil Val de Marne, Val de marne, Marne la Vallée, France

Between 2000 and 2010, Europe has suffered more than 175 major floods, causing deaths, large economic losses and displacement of people. In the decades to come, climate change is expected to increase the intensity and frequency of flood events. As urbanization in flood-prone areas still continues, the flood issue becomes one of the big challenges for cities in the future. Within this context, it appears that flood risk management is not only about controlling the rivers with protection systems anymore. Since the 1990s, most European countries are developing a multitude of strategies against floods.

Within the STAR–FLOOD project (www.starflood.eu), five Flood Risk Strategies are identified: risk prevention, flood defence, flood mitigation, flood preparation and flood recovery. The project investigates these strategies in six European countries (England, Belgium, France, the Netherlands, Poland and Sweden). Its overall objective is to assess the institutional embedding of these strategies at the national and local scales from a combined public administration and legal perspective. The project aims to contribute to the identification of suitable experiences of Flood Risk Governance in Europe at the scale of urban regions. National country profiles have already been produced and local cases are researched.
In our presentation, we will discuss stability and change in flood risk management and we will share (French and Belgian) experiences with designing and implementing governance arrangements for flood risk management and we will highlight the main challenges and opportunities ahead.

K-3337-02

The Resilience Pathway 2.0: a new way of city and area development with promising climate impact

E. Schellekens (1)

(1) ARCADIS and Climate KIC, Water and Environment, Amersfoort, Netherlands

There is an urgent need for climate adaptation to avoid huge socio-economic losses (growing from today’s $6bn to $60bn p.a. by 2050 in the 136 largest coastal cities alone). However, non-availability of money and gaps in capacities are huge barriers. A flow of private money, either besides or apart from public money, needs to be unlocked if adaptation is to happen quickly enough.

Research (ABL / Ricardo AEA, 2013, Defra, 2013) shows that many cities (around 80% in Europe) have low or very low capacity and therefore cannot specify required resilience measures.

To unlock money flows and to raise capacity of stakeholders, ARCADIS and TPL have developed and successfully tested a new and unique high level business model, the Resilience Pathway 2.0, with European cities and have reached out to potential financial partners, with encouraging results.

Existing high level engineering skills and products and services have been brought together in partnership with leading deal-structuring experts and financial organisations to help riverine and coastal cities to access private and public money for climate adaptation.

Resilience is most needed for long-lasting decisions with outcomes that last 10+ years (e.g. water and other infrastructure), which need to be viable in unpredictable and fast changing future climate and energy scenarios, where the status quo is usually the least likely scenario. These decisions are difficult and or expensive to reverse (in money and energy terms). This is where identifying ‘moments of change’ and defining ‘investment opportunities’ seem the way to go, while creating a marriage between technical finance and social engineering. The main phases of the Resilience Pathway 2.0 that will be explained with real cases during the speech are as follows;

Phase 1: Scoping. The output of this first phase is a clear briefing document clarifying the challenges to be addressed, also to identify potential opportunities (‘moments of change’) to address them.

Phase 2: Optioneering[1]. The purpose of the Optioneering phase is to identify one or several promising, fundable and feasible risk cases around a development (or a combination of developments). These will provide alternative routes to meeting climate and other objectives of projects that will be attractive to private and other investors. Crucial phases in the Optioneering phase are bringing high-level engineering and financial thinking together is essential in unlocking finance for resilience.

Phase 3: Deal Structuring. The purpose of the third phase, the Deal structuring phase, is to transform the selected intervention opportunity – as identified in the Optioneering phase – into a contract with detailed specifications and financial and legal arrangements (e.g. permitting) to deliver the project objectives: resilient projects with an acceptable (typically low) risk–return profile.

Phase 4: Project implementation

The aim of the project implementation phase is to get the projects or developments realised and well managed. This phase is a missing link in many strategies.

To be able to implement this Resilience Pathway 2.0 mid and high level capacity is needed at the relevant stakeholders. The methodology both to assess and to improve the capabilities needed has been tested en proven.

And last but not least, the Resilience Pathway 2.0 generates high climate impact but also creates promising business opportunities to make it economically sustainable as well.

O-3337-01

Addressing flood risks at urban scale, the case of Geraardsbergen (Belgium)

H. Mees (1); VDC. Liesbiet (2)

(1) University of Antwerp, Sociology, Antwerp, Belgium; (2) City Geraardsbergen, Geraardsbergen, Belgium

With its location next to the Dender river, the city of Geraardsbergen (32,950 inhabitants) is highly susceptible to flooding. The Dender is a typical spate river: whereas its water discharge is normally low, it can rapidly grow in volume during wet periods. Consequently, the surrounding land along the river traditionally functioned as a large floodplain. With the development of the Regional Spatial Plan in 1978, a significant amount of this floodplain was marked as building zone. As a result, a rapid urbanization of the Dender region took place in the following decades. The consequences of this development became clear in the 1990s. Damage was caused by flooding in 1995, 1999, 2003 and 2010. Whereas the damage of the previous floods was restricted to a small number of properties, the flood of 2010 had a wide-scale impact; 398 houses were flooded with a damage cost of about 5 million euro.

After the 2010 flood, the City of Geraardsbergen has committed itself to a new approach, which aligns with the 3P’s prescribed by the Flood Directive (2007/60/EC). A coordinator for integrated water management was appointed, who has the task to keep an overview on the actions carried out by the different departments of the City Administration and to be a medium between the several water managers involved in the basin. The City strictly applies the water assessment tool proposed by the EC to make a commitment government in the deliverance of permits and has invested in measures to enhance preparedness, e.g. the mobile dams and SMS—warning service.

Improvements in flood risk management are however hampered by a number of factors contributing to inertia. Firstly, the existing legislation on spatial planning limits the political and financial feasibility to avoid further development in flood-prone areas. Recently, however, a new legal instrument was developed which should facilitate municipalities to swap land destinations. Geraardsbergen is currently investigating this possibility.

Secondly, the flood safety of the Dender basin is dependent on the infrastructure on the river. By rectifying the river and building up its floodplains, flood damage is only to be prevented by an efficient drainage of the water discharge. This is currently hampered by the outdated sluice infrastructure, which needs to be replaced. Due to complex decision-making procedures, however, the renovation is consistently delayed.

In our presentation, we want to share experiences on integrated flood risk management at urban scale. We will give an overview of recent developments in the flood management of Geraardsbergen, address remaining bottlenecks and present some possible solutions to be discussed with the audience. The evaluation is based on the results of the STAR—FLOOD project, which analysed flood risk management in Geraardsbergen in comparison to two other cities and the national policy-making level. The research was conducted through juridical and policy analysis of relevant legislation, policy documents and interviews with stakeholders. The results of the research were discussed by the interviewed stakeholders on a workshop held in January 2015.

References:
Flood risk management and intercommunal cooperation: Lessons learnt from the experiences of Nevers (Middle Loire, France) and Le Havre (Seine Estuary, France) Agglomerations

M. Fournier (1); G. Mathilde (2)
(1) Ecole Supérieure des Géomètres et Topographes – CNAM, Le Mans, France; (2) Université François-Rabelais Tours, UMR Citéres CNRS 7324, TOURS Cedex 3, France

The coming decades are likely to see a higher flood risk in Europe, both on coastal areas and along rivers in the inner lands. In this context, the EU FP7 project STAR-FLOOD (http://www.starflood.eu/) reassigned European flood risk practices: towards appropriate and resilient flood risk governance arrangements” assumes that urban areas will be more resilient if the existing Flood Risk Strategies (risk prevention, flood defence, flood mitigation, flood preparation, flood recovery) are implemented simultaneously and aligned. From this assumption, the STAR-FLOOD project questions, in various case studies from six European countries (Belgium, England, France, The Netherlands, Poland, Sweden), the institutional embedding of those different strategies and flood risk governance at the local scale.

In France, responsibilities for those different Flood Risk Strategies are mainly divided between municipalities and the State administration. Municipalities have competences in the fields of flood prevention and flood preparation. Such responsibilities are quite heavy and difficult to face for many of them. As a consequence, intercommunal structures is becoming more and more frequent in this field. In previous researches, we demonstrated that the setting up of intercommunal structures has progressively allowed local authorities to better deal with environmental issues, leading to the production of new action areas and a rethinking of environmental problems (Larrue, Fournier, 2014; Amalric et al., 2011).

Our contribution will illustrate this evolution and highlight the role of intercommunal structures to better address the flood issue and facilitate alignement of the different Flood Risk Strategies locally. Our presentation is based on the example of two French agglomerations: Nevers and Le Havre Agglomerations, which are both of them case studies in the STAR-FLOOD project. Both of them are already subject to intense debates in flood risk management and it is possible to draw lessons from their experience.

Nevers Agglomeration is a medium-size urban agglomeration (encompassing the community of Nevers (about 36 000 inhabitants in 2011) and 11 other smaller municipalities (about 68 000 inhabitants in total). It is located at the confluence between the Allier, Nièvre and Loire rivers, which are subject to floods from their runoff. Safety on dikes is also a major issue, as most of them have been built several centuries ago.

Le Havre was about 174 155 inhabitants in 2011. Le Havre is a multi-risk city with an industrial background based on the activity of the harbour. Le Havre is also at the fringe of an agricultural and farming area, composed of intensive agriculture, open fields and meadows. The main consequence for water management is the increase of soil erosion and land degradation. Above all, Le Havre is losing population since the 1980’s. The risk of losing population is considered as an immediate danger by the local stakeholders. Floods are seen as less dangerous than a decrease of economical and urban growth.

In this contribution, we will describe how both Agglomerations are progressively taking the lead for flood management and facilitate coordination between Flood Risk Strategies.

In the case of Nevers Agglomeration, intercommunal cooperation has enabled local authorities to take the lead in a comprehensive approach of the flood risk. In 2007, Nevers Agglomeration launched a major study of the flood risk addressing both hydraulic and vulnerability issues on its territory. This study has provided intercommunal authorities with inputs and resources to negotiate with the State administration on the flood issue. Intermunicipal cooperation has also been a real asset to promote innovative strategies, align local protection and mitigation measures and better deal with flood preparation and management crisis locally.

In the case of Le Havre, the intercommunal structure provides a range of resources (human resources, technical skills, engineering response capacity and financial powers) to all the municipalities for risk management, based on a strong local expertise in the field of Industrial Risk Management since the 1970’s. The local intercommunal structure gathers a joint coalition to negotiate the scenario proposed by the State, not only to discuss the implementation but also to define the level of occurrence of flood.

Sharing the funding of Flood Risk Management: The impact of Partnership Funding on the River Thames Scheme, London

AP. Micou (1); S. Priest, (1); M. Alexander (1)
(1) Middlesex University, Flood hazard research centre, London, United Kingdom

Cities across Europe are suffering increasing flood risks due primarily to urbanization and climate change. As a response to this, a variety of rule changes are being adopted to tackle this problem at a European, national and regional level. An assessment of the effects of national policy on the delivery of Flood Risk Management at a local level has been carried out as part of the EU project STAR-FLOOD (http://www.starflood.eu/). In England, the Coastal and Flood Erosion Resilience Partnership Funding (‘Partnership Funding’ Defra 2011) describes a new approach to funding which requires the costs of many flood risk management projects to be shared between national and local funding sources, such as via local governments, the private sector or civil society. The introduction of Partnership Funding was as a direct response to the need to unlock additional route streams and broaden risk sharing arrangements under scenarios of increasing risk. However, a consequence of this policy change is also a further impact upon the governance arrangement at a project scale: including the involvement of other actors, their responsibilities, their relationships as well as the power they exert within a decision-making process.

Based on interviews conducted with representatives from the local and national government, this work assesses how the Partnership Funding is impacting on the implementation of one particular project: the River Thames Scheme (RTS), in South East England. The project management strategy involves the construction of three alleviation channels to control floods in the Lower Thames segment (situated West from London), as well as other measures, such as the installation of property level measures and the development of new early warning systems, protecting in total 15,000 properties. The project has been approved but it is still subject to identifying locally sourced funding. The study presents an analysis and evaluation of the flood risk governance model that has informed these decisions, revealing the barriers of involving local government (of which there are seven separate councils involved) in the development of large scale flood risk management schemes. However, the study also highlights the advantages and opportunities which this new funding mechanism brings to the Flood Risk Management agenda, in particular the increased flexibility which this has permitted and previously undelivered flood defence strategies in the Lower Thames. The evaluation considers the impact on efficiency and legitimacy of flood risk governance and on the current and long term societal resilience in the area of interest.

Coupling Mobile Sensing, Earth Observations and E-GNSS in a Novel Flood Emergency Service

C. Rossi (1); S. Wolfgang (2); B. Conrad (3); Z. Gunter (4); C. Nina (5); P. Davide (6); S. Emiliano (7); F. Dominici (8)
(1) Istituto Superiore Mario Boella, Microsoft Innovation Center, Torino, Italy; (2) GeoVille Information Systems GmbH, Innsbruck, Austria; (3) EDD Rhein, Germany; (4) Terranea UG, Bürgstadt, Germany; (5) NDConsult, London, United Kingdom; (6) UNESCO, Venice, Italy; (7) ALFA Consult, Milan, Italy; (8) Istituto Superiore Mario Boella, Mobile solutions, Torino, Italy
Periodic flood events devastating urban and suburban areas are an important issue for mankind. Flood events, especially in Europe, have, in recent years, caused significant human and economic losses, especially affecting densely populated areas. The consequences of floods are exacerbated by urban sprawl and climate change, especially in areas close to large streams and rivers. This situation can produce flash floods that are very difficult to predict and hard to manage with respect to citizen alerting, operational planning, and flood plain area prediction. According to recent reports, between 1980 and 2008 there were around 2800 floods worldwide, with almost 280 people killed and resulting in approximately 400 billion dollars of economic damages.

These facts point to the need to improve the timeliness and intelligence of flood emergency systems to help public administrations to better address and manage flood-related emergencies. Indeed, advanced monitoring and forecasting services are becoming mandatory to better address and mitigate crisis situations arising before, during and after heavy flood events.

Today, most advanced flood emergency management systems can rely on Earth Observations (EO) to acquire relevant imagery for processing, spatial analysis and dissemination via a range of technologies including geographic information systems. In terms of crisis management, disaster monitoring and natural disaster observation is one of the leading technologies, as it allows the capturing of important measurements of the hazard, both in near-realtime as well as after the event. The Floods Monitoring and Management System (FMMS) provides mapping services for all actors involved in the management of natural disasters, with accurate geospatial information derived from EO and complemented with in situ operational water level data, to support the collection of a wide range of measurements for different natural disasters including forest fires and floods, and they can also be used to produce detailed Digital Elevation Models (DEM) of the Earth. Overall, EO can provide current data of a specific area, allowing the creation of flood delineation maps with different time resolutions, depending on the geographical area and the source of satellite data. However, due to the administrative operations required by the activation procedures and the need for satellites acquiring current images, some days can pass between the occurrence of a flood and its first mapping. This delay is not ideal during rapidly occurring emergency events such as flash floods, posing a significant limit in quickly providing reliable flood extent and forecast map.

To overcome the aforementioned limitations we propose FLOODIS: a novel Copernicus downstream service that exploits existing space assets together with mobile sensing and state-of-the-art cloud computing. FLOODIS leverages the mobile sensing paradigm to improve the timeliness of accessing flood disaster related information by letting users report the flood extent or near real-time events through their smartphones and tablets. FLOODIS is actually taking place and how the dynamics found can be scored using our criteria. The findings reconfirm the notion of “more resilient flood risk governance” into five criteria: resistance, robustness, ability to absorb and recover, social learning, and ability to adapt. Third, we use examples from flood risk governance in Europe (the EU FP7 project STAR-FLOOD) to discuss to what extent a diversification of FRM strategies is actually taking place and how the dynamics found can be scored using our criteria. The findings reconfirm the notion of “more resilient flood risk governance” into five criteria: resistance, robustness, ability to absorb and recover, social learning, and ability to adapt.

Unpacking the notion of “more resilient flood risk governance” – a framework with examples from flood risk governance in Europe

P. Driessen, (1) ; RM. Van (2) ; D. Hegger (3) ; M. Bakker (4) ; ZW. Kundzewicz (5) ; M. Wiering, (6) ; T. Raadgever, (7) ; A. Crabbe (8)

(1) Copernicus Institute of Sustainable Development, Utrecht University, Utrecht, Netherlands; (2) Utrecht Centre for Water, Ocean systems and Sustainability Law, Utrecht, Netherlands; (3) Utrecht University, Environmental Governance, Copernicus Institute of Sustainable Development, Utrecht, Netherlands; (4) Utrecht University, Utrecht, Netherlands; (5) Polish Academy of Sciences, Institute of Hydrology, Poznan, Poland; (6) University of Antwerp, Antwerp, Belgium; (7) University of Maastricht, Maastricht, Netherlands; (8) University of Antwerp, Antwerp, Belgium.

European countries, especially urban areas, face increasing flood risks due to urbanisation and the effects of climate change. In literature and practice, it is argued that a diversification of Flood Risk Management Strategies makes urban agglomerations more resilient to flood risks. The latter requires innovations in existing flood risk governance arrangements, development of new arrangements and the coordination of these arrangements. We argue that the notion that diversified FRM leads to more resilience to flood risks is a plausible proposition, but one that should be explored through comparative research. To do this, we present a brief overview of the state of the art of literature on resilience of social–ecological systems and flood risk governance. Next, based on the literature review, we operationalise the notion of “more resilient flood risk governance” into five criteria: resistance, robustness, ability to absorb and recover, social learning, and ability to adapt. Third, we use examples from flood risk governance in Europe (the EU FP7 project STAR-FLOOD) to discuss to what extent a diversification of FRM strategies is actually taking place and how the dynamics found can be scored using our criteria. The findings reconfirm the notion of “more resilient flood risk governance” into five criteria: resistance, robustness, ability to absorb and recover, social learning, and ability to adapt.

Probabilistic, multi-variate flood damage modelling supports better decisions in flood risk management

H. Kreibich (1) ; K. Schröter, (1)

(1) German Research Centre for Geosciences, Section Hydrology, Potsdam, Germany

Decisions on flood risk management and adaptation are increasingly based on risk analyses. Such analyses are associated with considerable uncertainty, even more if changes in risk due to global change are expected. Although uncertainty analysis and probabilistic approaches have received increased attention recently, they are hardly applied in flood damage assessments. Most of the damage models usually applied in standard practice have in common that complex damaging processes are described by simple, deterministic approaches like stage–damage functions.

This presentation will show approaches for probabilistic, multi-variate flood damage modelling on the micro- and meso-scale, i.e. for individual objects and for aggregated land use units, and will discuss their potential and limitations.

For instance, we compared the predictive capability of six flood damage models (four deterministic and two probabilistic models) in a spatially and temporally extended domain. We used empirical damage data which are available from computer-aided telephone interviews that were compiled after the

European countries, especially urban areas, face increasing flood risks due to urbanisation and the effects of climate change. In literature and practice, it is argued that a diversification of Flood Risk Management Strategies makes urban agglomerations more resilient to flood risks. The latter requires innovations in existing flood risk governance arrangements, development of new arrangements and the coordination of these arrangements. We argue that the notion that diversified FRM leads to more resilience to flood risks is a plausible proposition, but one that should be explored through comparative research. To do this, we present a brief overview of the state of the art of literature on resilience of social–ecological systems and flood risk governance. Next, based on the literature review, we operationalise the notion of “more resilient flood risk governance” into five criteria: resistance, robustness, ability to absorb and recover, social learning, and ability to adapt. Third, we use examples from flood risk governance in Europe (the EU FP7 project STAR-FLOOD) to discuss to what extent a diversification of FRM strategies is actually taking place and how the dynamics found can be scored using our criteria. The findings reconfirm the notion of “more resilient flood risk governance” into five criteria: resistance, robustness, ability to absorb and recover, social learning, and ability to adapt.

Probabilistic, multi-variate flood damage modelling supports better decisions in flood risk management

H. Kreibich (1) ; K. Schröter, (1)

(1) German Research Centre for Geosciences, Section Hydrology, Potsdam, Germany

Decisions on flood risk management and adaptation are increasingly based on risk analyses. Such analyses are associated with considerable uncertainty, even more if changes in risk due to global change are expected. Although uncertainty analysis and probabilistic approaches have received increased attention recently, they are hardly applied in flood damage assessments. Most of the damage models usually applied in standard practice have in common that complex damaging processes are described by simple, deterministic approaches like stage–damage functions.

This presentation will show approaches for probabilistic, multi-variate flood damage modelling on the micro- and meso-scale, i.e. for individual objects and for aggregated land use units, and will discuss their potential and limitations.

For instance, we compared the predictive capability of six flood damage models (four deterministic and two probabilistic models) in a spatially and temporally extended domain. We used empirical damage data which are available from computer-aided telephone interviews that were compiled after the
climate change adaptation: towards a legal change?
T. Thullier (1)
(1) Université François Rabelais, UFR Droit, Économie et Sciences Sociales, Tours, France
The world is facing climate change, which impacts on the international community at large. Such a problem requires a global response followed by local actions to deal with this new challenge. This response is characterized by the crossing of mitigation measures, in order to reduce greenhouse gas emissions, and adaptation measures for reducing the risk and damage from current (ex post aspect) and future (ex ante aspect) harmful impacts. Among the different effects compiled by the Intergovernmental Panel on Climate Change (IPCC), we could note for instance rising sea level or more frequent flash floods and marine submersion. Statistical studies have shown that natural disasters will be increasingly important in the next few years. Therefore, it is urgently necessary to draw up adaptation and risk reduction measures and all the instruments of public policy, such as normative instrument law, have to be mobilized.

These last years, France has established a real adaptation to climate change policy through the development of the National Climate Change Adaptation Plan (PNACC) provided for in the Grenelle Act of 2009. Indeed, this plan is consistent with the European strategy of adaptation to climate change adopted in 2013 by the European Commission, which invites every Member State to adopt comprehensive adaptation strategies. When analysing on a legal point of view these different plans or strategies adopted at national or European level, one may see there weak normative force. Even if the Grenelle Act of 2009 makes provision in Article 42 for “the preparation of a National Adaptation Plan for a variety of areas of activity by 2011”, one may say that it has no legal value. Indeed, the plan has not been adopted by the French Parliament or the Government through a regulatory act. Only a consultation was carried out in 2010 bringing together panels from the Grenelle Environment Forum (elected representatives and local authorities, the state, employers, employee unions and non-profit associations). At the European level, the Strategy of adaptation to climate change has been drawn up through a communication of the European Commission. These two plans can both described as soft law instruments used to improve stakeholders support (Dreyfus & Patt, 2011).

Even if such an intention can be laudable, it must be remembered that States are responsible for human security. This responsibility belongs to the political and legal domains. From an intern and European legal point of view, there is no explicit obligation stating that a State has to protect its population against the consequences of climate change impacts. Yet, the French disaster law is composed of the protection principle, which enjoins the State and local authorities to protect effectively their population when a natural disaster happens (Cans at al., 2014). At the European level, the European Convention for the Protection of Human Rights and Fundamental Freedoms (ECHR) protects the right to life and imposes positive obligations on Member States to guarantee this fundamental right (Gouritin, 2009).

In order to avoid any action for damages against public authorities and to constrain actors to prepare effectively to climate change consequences, the implementation of a real arsenal of hard law provisions is necessary.

But how can we incorporate this variable “climate change”, characterized by its uncertainty and its permanent evolution in progress, into normative instrument which are traditionally looking for a certain degree of legal certainty?

The purpose of this communication is to analyse some French legislative instruments directly or indirectly used in the field of flood risk management (flood risk prevention plan [PPRI], flood risk management plan [PGR], local urban planning scheme [PLU], territorial consistency plan [SCOT]) from a climate change perspective. The main issue for this topic is to what extent these different instruments can be a vehicle for adaptation to climate change. On conclusion to this study, concrete propositions will be made in order to better integrate data linked to climate change into these legal instruments.
ABSTRACT BOOK
International Scientific Conference     7-10 JULY 2015    PARIS, FRANCE

P-3338-01
Floods and International River Basin Districts: Europe stands United?  
C. Suykens (1)  
(1) Institute for Environmental and Energy Law, Public Law, Leuven, Belgium

Problem definition

Through the introduction of the concept of International River Basin Districts (IRBDs), water law in Europe aims to focus on ecological boundaries as opposed to administrative boundaries. Considering the fact that approximately 60% of EU water is transboundary, and there are transboundary waters in all Member States with the exception of Cyprus and Malta, solid cooperation and conflict prevention mechanisms throughout EU Member States are critical for ensuring quantitative water security. Indeed, actions upstream (in one country) impact the quality and quantity of water downstream (in the part of the river basin located in a neighbouring country) and vice versa. The floods in Central Europe in 2013 demonstrate the transboundary nature of the phenomena, as the floods emerged in one jurisdiction and proliferated in other jurisdictions. However, as will be demonstrated, solid mechanisms for cooperation are lacking in the European legal framework with regard to IRBDs.

Outline of the presentation

This contribution will review how the EU legal framework drives cooperation in IRBDs, in order to tackle the inherently transboundary issue of flooding. This will be done on the basis of the five pillars of transboundary water governance, as set forth by the Global Water Partnership, namely (i) scope, (ii) substantive rules, (iii) procedural rules, (iv) institutional mechanisms and (v) dispute resolution.

Through the framework of these five pillars, the existing bottlenecks in the EU framework will be identified. On the basis of this analysis, ways forward will be set forth, amongst others drawing from a legal comparative analysis with transboundary river governance agreements in the United States.

O-3339-01
Three stylised policy scenarios
P. Drummond (1)  
(1) University College London, Institute for Sustainable Resources, London, United Kingdom

This presentation will focus on the results of a paper assessing the ability of three stylised policy scenarios to deliver the low-carbon energy infrastructure required in the EU by 2050. First, key infrastructure requirements as commonly agreed by modelling studies will be outlined across the key sectors of power generation, industry, buildings and transport, with ‘infrastructure’ encompassing both stationary and mobile components of the energy system (from power generation to vehicles). The three stylised scenarios will then be introduced, each centred on a particular policy paradigm (market-based, technology-based and behaviour-based). Following this, the key benefits and problems associated with each, and their ability to deliver the energy infrastructure outlined for each sector, will be presented.

O-3339-02
Dealing with uncertainty in the European climate policy
O. Lecuyer, (1) ; P. Quirion (2)  
(1) University of Bern, Occr, Bern, Switzerland; (2) CNRS, Cired, Nogent sur Marne, France

While the European climate policy has been the target of a large number of economic analyses, both from academics and from the European Commission services, almost all modelling exercises have been deterministic, allowing at best for testing a few scenarios. Stochastic models have been developed but in most cases without numerical application to climate policies. In the few exceptions, the climate policy only consists in CO2 pricing, implemented either through a tax, an ETS or a rate-based policy (e.g. an intensity target).

Yet the history of climate policy is full of surprises, including the swings in EU ETS allowance price and the unexpected surge in PV installation in Germany. We develop a simple stochastic model of the European energy sector featuring the most important uncertainty sources in this context, i.e. economic growth and the cost of key technologies, as well as the interaction between climate policy and renewable energy subsidies.

It turns out that uncertainty changes the (ex ante) optimal policy choice. In particular, most analysts conclude that if CO2 emissions from the power sector are covered by an ETS, there is no or little rationale for renewable energy subsidies. Yet, if uncertainty is high enough, emissions may fall below the ETS cap in some states of the world, leading to a nil allowance price. Hence, energy subsidies at a proper level are justified as a kind of insurance that at least some state of the world will happen in these states of the world, which is welcome since the marginal benefit of GHG abatement is positive in these states of the world also.

This point is not only theoretical: a careful examination of existing and past ETS worldwide indicates that for most of them, emissions have been significantly below the cap during at least a part of their history. Moreover there is no guarantee that the Market Stability Reserve proposed by the European Commission will be adopted by the Council and the Parliament, and most analyses conclude that this mechanism is unlikely to stabilise the CO2 price significantly.

Moreover, we show that the design of renewable energy subsidies should take into account uncertainty. In particular, feed-in-tariff, premium and renewable quota all respond in a specific way to a change in renewable energy cost, in fossil fuels price or in electricity demand. A model is designed to implement them when implemented in isolation, which concludes that a renewable quota is by far the worst instrument, mostly because it does not respond to a change in renewable energy cost or in fossil fuels prices. Finally, we analyse how this ranking of renewable subsidy instruments changes when they are implemented together with an ETS, as is currently the case in the EU. Compared to the premium, the feed-in-tariff provides a subsidy which decreases with the electricity price, itself positively correlated to the CO2 price. Hence it helps to stabilise the marginal abatement cost, which is welcome for a stock pollutant like GHG gases, whose marginal benefit curve is flat.

O-3339-03
The availability of finance for the low carbon economy. Eco innovation diffusion, sector analyses and green climate funding
M. Mazzanti (1) ; Z. Mariangela (2) ; G. Claudia (3) ; A. Davide (3) ; M. Susanna (3) ; V. Costantini (4)  
(1) University of Ferrara, SEEDS; (2) Environment and Energy Law, Public Law, Leuven, Belgium; (3) University of Ferrara, SEEDS; (4) Roma Tre University, Department of Economics, Rome, Italy

The macroeconomic setting is slowly moving towards financing the green / low carbon economy with diversified private and public oriented sources. Nevertheless, if compared to the mass of potential liquidity this
development is still in its infancy.

Sector, firm based and macro evidence is presented and integrated.

We do highlight three key findings among others.

At firm level, the overall evidence could reinforce the literatures: firms, sectors, regions in the EU; some of those could possess irreversible features and create ‘hot spots’, namely structurally underperforming regions / sectors.

Second, financial barriers confirm to be a deterrent for the innovative capacity of EU firms in the current situation, if observe the overall quanti-qualitative evidence. This is true for the economy as a whole, and for manufacturing or construction firms taken alone. Being smaller and having low human capital in the firm also hampers environmental innovations (EI). On the ‘positive’ side, we note that existing regulations and expected increasing demand for green products support EI adoption. Financial barriers are perceived as a barrier to innovation and not as technological uncertainty on investments, non-competitive markets, and lack of subsidies. While policies are driving innovations to some extent, ‘external knowledge sourcing’ seems not to play any significant role in this context. This highlights a strong critical issue: external finance elements deters EI and external knowledge is not as acting as a potential substitute; firms are currently isolated islands towards the green economy, with respect to other firms and financial institutions.

At macro level, the possibility to use environmental policy reforms is assessed by a dynamic CGE modelling approach that analyses the case of Green Climate Funds, which are eventually generated out of carbon taxes revenues and might support sector eco innovative dynamics following countries specific needs. Green Climate Funds financed through a levy on carbon can benefit all parties, and larger benefits are associated with energy efficiency in developing countries.

O-3339-04

The politics of policy choice. Understanding political feasibility of climate policy instruments in the EU

S. Munaretto (1) ; H. Walz (1) ; D. Huitema (1)
(1) Institute for Environmental Studies (IVM), VU University, Amsterdam, Netherlands

The EU has adopted a mix of policy instruments to achieve its carbon emission reduction targets. However, market and governance failures have led to major inefficiencies, and many call for a revision of the existing instrument mix. But what policy options are politically feasible? Political feasibility is still poorly understood, and the literature falls short in definitions, methods and empirical studies. In this paper we advance the current state of knowledge by developing a systematic framework that integrates 3 key dimensions of political feasibility, namely power dynamics among relevant interest groups, their preferences for policy instruments and the institutional setting in which proposals for instruments are discussed. The study provides novel insights into the relationship between these dimensions and the political feasibility of different typologies of instruments in the context of the EU climate policy. The approach is based on a multi-method approach that includes interviews, focus groups, an online survey and a policy simulation with relevant stakeholders.

P-3339-01

Agriculture: the sleeping beauty of European climate policy? How market-based instruments could reduce emissions

G. Grosjean (1) ; W. Acworth (1) ; S. De Cara (2) ; S. Fuss (3) ; N. Koch, (3)
(1) Potsdam Institute for Climate Impact Research, Potsdam, Germany; (2) INRA, Economics, Paris, France; (3) Mercator Research Institute on Global Commons and Climate Change (MCC), Resources and International Trade, Berlin, Germany

In order to achieve its long-term emissions reduction goals, the European Union has to significantly reduce its emissions from agriculture. The recent reform intended to “green” the Common Agricultural Policy is unlikely to sufficiently reduce agricultural emissions, although it might have other environmental benefits. Therefore, more ambitious mitigation policies will be necessary for European agriculture if policymakers do not want to jeopardize the achievement of the overall long-term targets. Several studies also show that there is a significant mitigation potential in European agriculture that can be harnessed cost-effectively by the implementation of market-based instruments.

Nonetheless, major barriers appear to make agriculture relatively challenging to decarbonize. In particular, this paper argues that challenges linked to (i) transaction costs, (ii) political economy and behavioral specificities of actors in the sector complicate the implementation of ambitious mitigation policies. Market-based instruments may imply significant transaction costs for farmers, for instance, related to monitoring, reporting and verification. The specificities of the sector and the degree of protection it benefits through the Common Agricultural Policy also make it more delicate to price its emissions. This interaction between climate policy and the existing CAP will in fact likely be at the heart of any mitigation policy in the sector. Finally, it is also important to take into consideration behavioral aspects and that financial incentives alone might not always be sufficient.

To that end, this paper offers a new framework to map options to implement climate policies in the sector, while taking into consideration the main obstacles. The coverage is the percentage of agricultural emissions covered by a climate policy, which is driven by emission sources and the farm size in term of emissions included. The degree of stringency is the type of policy implemented. It can be a voluntary or mandatory, going from offsets to full emission in the EU ETS or an emission tax. The transfer dimension reflects the net impact on farmers of the interaction between a new climate policy and the existing CAP subsidies. In fact, it is argued that it is necessary to explicitly discuss potential interactions. Simultaneously, the existence of those subsidies might also represent an opportunity to facilitate the political acceptance of a climate policy in the sector.

It is concluded that heterogeneous and multi-speed policies are necessary as a first step to tackle agricultural emissions. In fact, for emission sources where transaction costs are lower, mandatory mitigation mechanisms should be applied, while a voluntary approach could be implemented for emissions sources with high transaction costs. This would reduce transaction costs overtime and gradually enable farmers to decide on their own. In addition, the paper offers different options to choose from that combine different levels of transfer to farmers and various degree of protection against leakage. These options provide alternatives to policy makers to choose from taking into consideration their perceived political feasibility.

P-3339-02

Climate change challenges for European Union in the New Millennium

SK. Mishra (1)
(1) S. N. D. T. Women’s University, Continuing and Adult Education Work, Mumbai, Maharashtra, India
Strategies on climate change and development cooperation are both evolving rapidly within Europe. Improved scientific understanding about climate change and responses to it show the need for urgent action. This is the clash between emission reductions pledged by countries and the climate actions needed to achieve them within a safe carbon budget. The aid landscape is also changing fast, after years of seeming stability. With the emergence of new donors (both sovereign states and private foundations) comes the challenge of increasing aid dependency. As a result, the traditional multilateral and bilateral donors are likely to lose influence and power. But within the climate change framework there is still unfinished business for traditional donors, particularly in relation to the provision of finance and technology for developing countries.

Participants to the European Union (EU) has stepped up to its historic responsibilities and climate change has become an increasingly important component of its development cooperation effort. But how will this play out over the next decade and what can we learn from recent trends? This paper aims to seek answer to this question. Secondary data have been used in the paper and methodology of analysis is “descriptive research methods”. Within the framework of this objective, it touches upon relevance from development cooperation for climate change.

3340 - Conflict and Climate Change

ORAL PRESENTATIONS

O-3340-01

Climate Change: Adding Fuel to The Fire of Iran’s Inter-provincial Water Conflicts?

H. Najafi (1)

(1) University of Tehran, Tehran, Islamic Republic of Iran

Results recently found in the Iranian third national report on climate change reveal there is evidence that several parts of the country are likely to face hotter and drier climate in the future. Nevertheless, impact studies still have not been incorporated into decision making framework not only in the most recent national comprehensive water plan but also as a compulsory analysis of any development schemes at the implementation phase. This paper aims at highlighting the imperative role of climate change impact assessments studies on regional conflicts over shared water resources in Iran. Two of the most important river basins at the western part of Iran are illustrated: Lake Urmia and Karkheh. The former is shared between three provinces where the latter is shared between seven riparian ones. Lake Urmia has suffered serious environmental challenges in recent years. Thirty main rivers flowing into the lake are all experiencing decreasing surface runoffs in recent fifteen years ranging from 26 to 70 percent compared to their long term average of 1969–1999. Likewise, changes in potential renewable water resources have dropped by one forfh in Karkheh river basin attributing to several factors including decreasing trend of precipitation as well as increasing infiltration and overuse of water consumption. Since the observed trends in changing streamflow, policymakers have seriously attempted to attribute the contribution of each of the climate variability and change as well as basin-wide water consumptions. In response to these increasing pressures on water resources, the sustainability of resources should have been avoided. Meanwhile, recent impact studies over the two river basins have suggested that climate change is expected to aggravate water resources challenges under some projections of the IPCC’s AR4 emissions scenarios. Surprisingly enough, the competition over exhausting water resources is likely to turn out to be the Tragedy of the commons under compounded impacts of climate change and mismanagement measures leading to conflicts arising when available resources are diminished.

Each of the so called inter-provincial basins are managed by regional (provincial) water companies. The paper suggests that in addition to the past mismanagements which have been found as a driving force of current inter-provincial water conflicts, increasing temperature together with a decrease in mean annual rainfall and runoff in the face of climate change inevitably intensifies competition over the limited available resources. When surface water is temporarily unavailable then other sources will be sought after such as groundwater. Consequently, conflicts begin over the use and ownership of water in many settings. From 1974 to 2012, an average of 27 MCM of decrease per year has been observed in some basins adjacent to the Lake Urmia. In the view of this situation, neglecting to consider climate change projections is likely to expose natural systems to serious damage, even potentially irreversible. Many unsustainable ecosystems such as Lake Urmia and Hoor–Al–Azim marshland at the outlet of the Karkheh river basin. Considering the high vulnerability of water resources systems, agriculture, and energy sectors together with fragile socio-economic features, conflicts over these common pool resources, will probably be unavoidable. Ultimately, understanding the effects of current development plans and climatic changes on the status of the mentioned sectors can help taking timely actions to alleviate probable conflicts. Given such a scenario, there have recently been progressive attempts in the Iranian Ministry of Energy (MOE), the main organization responsible for water resources planning and management to launch a specialized working group to address climatic change related predicaments. However, this paper argues that there are some main stumbling blocks still remained untouched on the subject. Implementation of integrated river basin management, development of risk frameworks based on integrating top-down and Bottom-up approaches, thorough uncertainty analysis in addition to hedging between adaptation strategies and mitigation must be performed simultaneously. At the end of the paper, the paper suggests that climate change is likely to add salt to the wound of the current challenges from a multi-sectoral point of view and that comprehensive assessment of the impacts of climate change on water bodies followed by conflict resolution provides alerting symptoms for future decision making processes and further action plans.

O-3340-02

Climate-related disasters and armed conflict outbreaks- Evidence for significant co-incidences from the observational record

C. F. Schleussner (1) ; J. Donges, (2) ; R. Donner, (3)

(1) Climate Analytics, Berlin, Germany; (2) Potsdam Institute for Climate Impact Research, Earth System Analysis, Potsdam, Germany; (3) Potsdam Institute for Climate Impact Research, Potsdam, Germany

Armed conflicts are the result of a highly context-specific mixture of a variety of socio-economic factors and their multiple causality structure, which renders the attribution of armed conflicts to single factors a practically impossible task. Nonetheless, there is great interest in empirical evidence if and how much changes in potentially determining factors, in particular such related to climate change, alter the risk of conflict outbreaks at the global scale. Whether or not climate change is already contributing to armed conflict outbreaks and conflict risk is very controversial, in particular since the numerous interactions between climate change and socio-economic factors are difficult to capture by statistical methods.

Here we address this question regarding the specific case of climate-related extreme economic events. We present a comprehensive analysis of the co-occurrence between such events and conflict outbreaks for the period 1980-2011. While there is no significant statistical relationship between extreme damage events and the outbreak of armed conflicts at the global scale, for subsets of particularly conflict-prone countries of up to 10% or more of all conflict outbreaks robustly coincide with climate-related extreme economic damage events.

Our analysis reveals that climate-related extreme economic events, while not directly causing armed conflicts, can indeed significantly contribute to conflict risk in environmentally vulnerable and conflict-prone regions and possibly trigger the timing of conflict outbreaks. Given the still high number of countries at risk of observed and projected increase in severe climate extremes, this relation represents a serious risk to societies globally.
Climate change induced migration and conflicts in Nigeria

O. Ovuyewworoye (1)
(1) University of Benin, Geography and Regional Planning, Benin City, Edo State, Nigeria, Federal Republic of

The challenges associated with climate change have started threatening the common future of the world’s inhabitants. While the challenge of some localities is associated with too much water, others are experiencing the problem of too little water available for use. Nigeria is being threatened by these two climate change challenges and each of these scenarios will result to forced migration. While the southern part of Nigeria is experiencing coastal inundation due to sea level rise, the north is being afflicted with the burden of desertification. These combined forces of climate change impact in Nigeria, prompted this study that investigated the impact of climate change on migration and possible conflicts in Nigeria. Climatic data (air temperature, rainfall amount and rainy days) for 60 years (1955 –2014) from 30 synoptic stations in Nigeria were analysed to evaluate the possible signals of climate change. With the aid of Geographic Information System (GIS) techniques, the vulnerable areas due to coastal inundation and desertification were modelled, population affected was determined and the ecological zones that will absorb the potential migrants and the expected conflicts due to such migration were analysed. The GIS technique was also used to construct the isohyets and isotherms so as to analyze the changes in climatic patterns. Time series analysis was employed for the climatic trends. 600 copies of a questionnaire were administered in six states (three in the coastal area and three in the semi-arid region) randomly selected to solicit information on the level of vulnerability, impacts and local adaptation strategies to climate change and possible migration and conflicts. These were analysed using different statistical and cartographic techniques. The results show a rise in temperature of 1.92°C for the 60 years. Although decreasing rainfall amount and rainy days were observed, a slightly increasing rainfall amount was noticed in the coastal area in the past two decades. A gradual shift in reduced rainfall during the short dry season from August to July was noticed. Another observed pattern is the southward shift in the line dividing the double rainfall peaks, thus increasing the tropical continental climate area and decreasing equatorial climatic region. Moreover, while sea level rise of 1 metre will affect 5.4% of Nigeria’s landmass and 16% of the population, desertification will affect 38% of the landmass and 33% of the population.

Both events may force about 49% of Nigerians from the coastal and semi-arid regions to the guinea savannah and the northern part of the forest ecological zones. This will result to scramble for arable land for farming, grazing and water resources, among others. Conflict between farmers and herdsmen is already on in Nigeria and this may intensify with increasing impact of climate change on natural resources (arable land, grasses and water). Large scale conflicts between farmers and herdsmen have claimed 496 lives in the guinea savannah and the northern part of the forest ecological zones of Nigeria between 2013 and 2014. Adaptation measures are recommended to reduce the impacts of climate change and also to minimize migration and the associated conflicts.

Sovereignty: The Unfocused Era of ‘loss and damage’ at Climate Summit

A. Naznin (1)
(1) Australian National University, Fenner School of Environment and Society, Canberra, ACT, Australia

One of the major decisions of COP19 is a new “Warsaw International Mechanism will be created to provide help for poorer countries hit by extreme weather events” for loss and damage issue under the Cancun Adaptation Framework–CAF. However beneath this major outcome there is a deep concern and state security associated with which is yet, uncounted and overlooked. Slow onset events under loss and damage were identified as “sea level rise, glacial retreat and related impacts, salinization” etc., however, in the case of Bangladesh, “the discussion on sea level rise and salinization centred on approaches rather than needs” indicates the uncertainty and lack of investigation and measurement in this area. The technical paper of CAF and Warsaw negotiation text both have missed the dilemma of state security while they are concentrated on “Vulnerable developing countries will be the hardest hit due to their low adaptive capacity”; “Slow onset events are already affecting developing countries and the resulting loss and damage”. The CAF and Warsaw agreement both have clearly missed the regional security dimension. For example, the economy of Bangladesh is poor than India which should mean that India has better adaptive capacity than Bangladesh. Since Bangladesh and India share borders, and economic opportunity is far better in India, there is potential that India will be severely affected from any emergency or slow onset climatic events in Bangladesh. This paper investigates potential geographical changes following mass migration flow brought by the loss and damages in reference to water stress in regional scale. Using high level policy interviews conducted in Bangladesh and comparing two census data of Bangladesh–India, this paper presents two tipping points which offers an important insight of the state security risk.
ABSTRACT BOOK

Improving existing approaches to gender programming in engagement with gender in future research. Which researchers can use to ensure more meaningful research is integrating concepts of gender into their work. A conceptual model provides a baseline understanding of how to reconcile climate change and gender. This conceptual model capturing key components of 'meaningfulness'. Meaningfulness is ascribed as being a function of gender mainstreaming, the experience of gender, and the degree of action being taken. Using a systematic literature review methodology, 123 peer-reviewed ARV articles with a gender focus were analyzed. While 41% of analyzed articles were found to have high levels of meaningfulness, significant variations across regions and disciplines emerged. Research occurring in Sub-Saharan Africa was found to consistently engage with gender in a highly meaningful manner. Although a great deal of gender-focused ARV research is occurring in Bangladesh and Australia, overall, these nations exhibited low levels of meaningfulness. Health, environmental management, and hazards research emerged as disciplines engaging with gender in the most meaningful manner, although areas needing improvement became apparent. Gender-focused work in this field focuses almost exclusively on women, with very little research examining male experiences and no work accounting for those identifying outside the gender binary. Gender-focused work in this field focuses almost exclusively on women, with very little research examining male experiences and no work accounting for those identifying outside the gender binary.


Slow-onset disasters such as droughts usually occur with such frequency that people have no time to recover before the onset of the next drought. All members of the community suffer as a result of recurrent droughts, but the effects are often more severe on vulnerable groups such as children, elderly people, and some women. This paper uses the experiences of the relief organisation Kukang Naisha East Africa (KUMA) to understand the importance of looking beyond gender in humanitarian interventions. Here we focus on the importance of understanding the socio-economic and political context surrounding the drought and the associated humanitarian interventions, using a feminist lens to assess power relations. This includes looking into the aspect of vulnerability and resourcefulness in the context of food security, food distribution, nutrition, and livelihood assistance. Such knowledge is vital in improving existing approaches to gender programming in humanitarian organisations.

Women in Changing Climate: Findings from Cyclone Aila Affected Coastal Communities of Bangladesh. MA. Nahian (1); GT. Islam, (2); SK. Bala, (2) (1) International Centre for Diarrhoeal Disease Research, Bangladesh (icddr, b). Dhaka, Bangladesh; (2) Bangladesh University of Engineering and Technology (BUET), Institute of Water and Flood Management (iwfm). Dhaka, Bangladesh

Climate change is harsh reality in Bangladesh in terms of gradual changes and disaster events. The country has been identified as most vulnerable to tropical cyclones, third most vulnerable to sea level rise and sixth most vulnerable to floods. However, climate change associated adversity and vulnerability is contextual and gender specific and is magnifying the socially constructed inequalities between men and women where women are always the worst victim due to their gender differentiated roles and lack of access and control over resources. The study, carried out in three major cyclone Aila affected communities, tried to explore the gender dimension of climate change induced vulnerability considering women 'not only the victim rather an agent of change'. Contrary to common vulnerability analysis and studies, this study tried to quantify vulnerability with a developed matrix framework in a scale of 3.0. The gender dimension of climate change induced vulnerability has been assessed in terms of exposure, sensitivity and adaptive capacity; considering both gradual changes or climate events and disaster events or climate extremes. The primary idea of the vulnerability assessment has been derived from the concept of Sustainable Livelihood Framework and Harvard Gender Analytical Framework. Using the basic and simplest equation of 'Vulnerability = Exposure x Adaptive Capacity' a matrix framework calculated contextual vulnerability and total vulnerability based on community (women group only) perception. The vulnerability assessment of gender community, i.e., women has been done in Padmapukur and Gabura unions from Shyamnagar upazilla, Satkhira and Sylhet.
Dakhin Bedkashi union, Koyra upazilla of Khulna in 2012 where the impact of cyclone Aila was most pronounced and after effect was lasted for several years. The climate change induced vulnerability of gender community of Padmapukur, Gabura and Dakhin Bedkashi was 2.56, 2.53 and 2.61 respectively. It was found that, respondents from Padmapukur and Gabura unions perceived themselves more vulnerable to climate change associated gradual changes or climate events whereas Dakhin Bedkashi respondents perceived themselves more vulnerable to climate change associated extremes or disaster events. Interestingly, the perceptions greatly coincided with direct impact, number of casualties, damage done and post disaster response and development intervention as well as location of study areas. The basic idea behind the vulnerability assessment matrix development was to provide tool that can capture overall gender dimension of vulnerability besides the direct impact of climate change, based on their perception ranked impact (exposure), effect (sensitivity) and effectiveness (adaptive capacity) to assess their geo-specific vulnerability; the total vulnerability score for all three study area lied in moderate to extreme category. The linkage among exposure, sensitivity and adaptive capacity showed that Bangladesh had achieved remarkably success in disaster preparedness; but significantly lacked experience to deal with the ongoing changes taking place in climate. The study also explored various complexities experienced by only women due to climate change associated events and extremes and accumulated suggestion for disaster preparedness, improvement in cyclone warning signal and modification for gender friendly design of cyclone shelters. Key suggestions also been assessed in line with climate change other disaster risk mitigation and preparedness, to enhance community resilience from the climate vulnerable community. Women is the integral part of the society and sustainable development initiatives and based on the overall findings, the study suggested ‘bottom up—top support’ institutional framework for gender mainstreaming.

O-3341-04

Household Dynamics in Adoption of Resilient Farming Technologies in Semi-arid Kenya

D. Kangogo (1)

(1) International Development Research Centre (IDRC), Agriculture and Food Security, Nairobi, Kenya

Countries in sub-Saharan Africa are particularly vulnerable to climate change, given their limited capacity to adapt. Strengthening resilience by adopting and promoting agricultural technology innovations is a fundamental means of improving incomes and food security for the largest group of food insecure households. To build such systems, development practitioners have advocated for an agroecological and climate-smart agriculture system that sustains productivity and system resilience while reducing vulnerability of smallholder farmers. This requires a substantial investment in agricultural technology innovations, and promotion of a system that sustains productivity and system resilience while reducing vulnerability of smallholder farmers. This study focused on the adoption of three technologies; improved maize seeds, improved green gram seeds and indigenous chicken. Based on household survey data collected from Machakos and Makueni counties of Kenya, this study sought to determine the gender differences in the adoption of multiple resilient farming technologies among the smallholder farmers in semi-arid eastern Kenya using a gender lens. The gender differences in the gender identification of the adoption of these technologies was examined. It also examines the factors that influence household level of resilience measured by the number and types of technology adopted by the respondent. Results show that male-headed households differ significantly with the facto female-headed households in terms of age, education, number of trainings and the adoption of a combination of improved maize and indigenous chicken. Male-headed and de jure female-headed households differ significantly with regard to age, education, crop mix, remittances and the adoption of improved maize, improved green grams and a combination of a combination of improved maize and indigenous chicken. Ordered probit model results on determinants of household resilience indicate that household type, education, land size, crop mix and market opportunity groups are key in influencing household resilience. This emphasizes the need for greater investment in gender and rural agricultural development to ensure equitable and sustainable livelihood improvements.

O-3341-05

Policy Gains and Implementation Opportunities: Progress on the Gender and Climate Change Front

M. Granat (1); L. Aguilar, (1)

(1) International Union for Conservation of Nature, Global Gender Office, Washington, DC, United States of America

In Jordan, women’s management of small–scale irrigation projects and involvement in water harvesting and soil conservation improves the efficiency of water use. In Nepal, women farmers avoid crop failure in the face of changing weather patterns by growing off–season vegetables and bananas, which are more resilient to flood and drought. In Mozambique, women’s groups and traditional healers can offset the impacts of climate change and improve community health with ‘climate change health kits’—comprising traditional and local medicinal plants, like citronella to ward off mosquitoes. Women often lead the way in adapting to climate change impacts, but they also play a key role in mitigating climate change by optimizing energy efficiency, using low-footprint energy sources and techniques, playing a vital role in forest management and mechanisms such as REDD+, and influencing a household’s and community’s consumption patterns.

Until recently, policy at the global and national level did not reflect this reality. For more than twenty years gender was absent from the United Nations Framework Convention on Climate Change (UNFCCC) and in the decision making by its Parties and in subsidiary bodies. This lack of a connection at the global and national level between gender and climate change prompted action on the issue. Now, after years of advocacy, outreach, capacity building, and awareness–raising, governments have agreed multilaterally that advancing gender equality is a key component in achieving climate change goals.

Since 2008, nearly 40 UNFCCC decisions on climate change have integrated specific text on gender concerns. From promoting women’s participation and leadership to gender safeguards and assessments, all vital areas of climate change response include key issues for women’s and gender equality—all toward ensuring more effective climate change policies. At COP15 in Copenhagen and COP16 in Lima, Parties decided on further action for implementation of the mandates through a specific gender decision and the creation of the 2-year Lima Work Programme on Gender.

This session will explore the opportunities for implementation of the Lima work programme and how it can make an advance gender equality and gender-responsive international climate change policy. A critical step in the implementation process will be presented at this conference: how to effectively anchor the international agreements on gender and climate change within the national contexts.

Over the last five years, International Union for Conservation of Nature (IUCN) Global Gender Office (GGO) has spearheaded innovative work on this very topic. It has supported, to date, 15 countries through processes to develop national Climate Change and Gender Action Plans (ccGAPs). This unique, low-footprint, multi-sectorial approach, gender responsive components into national climate change strategies, communications, programmes, and projects. An important principle of the ccGAP methodology is to ‘value women’s participation in the climate change response—so women and men alike are not merely victims but resilient agents of change.’
Mainstreaming gender in climate compatible development

V. Le Masson (1)
(1) Overseas Development Institute, Social Development / Climate and Environment, LONDON, United Kingdom

While there has been progress on acknowledging the gender dimension as an integral part of climate policy at international, national and local levels around the world, there is still a long way to go to promote gender equality in climate negotiations.

Yet, recognising and exploring the gender dimension of climate change enables responses to be more grounded in people’s daily realities. Through highlighting societal factors that influence people’s vulnerability to environmental shocks and stresses, a gender perspective helps uncovering for instance, how men are distanced to the point of suicide in India due to agricultural losses leading to an inability to repay loans[i]; and the way in which women are more likely to die from floods because they have not learned to swim[ii] and cannot leave their houses without being accompanied by a male relative[iii].

A gender analysis in climate research allows understanding of socially constructed gender roles, relations and discrimination that shape the way climate change is perceived by men and women, how it will affect them differently and how they might organise different responses to mitigate greenhouse gas emissions and adapt to longer-term impacts. This recognition has influenced the climate change and development communities to adopt various mainstreaming approaches to integrate gender into projects and programmes.

This presentation will document a few examples where projects have integrated gender considerations to highlight:

- what knowledge a gender approach enabled to uncover
- challenges and opportunities to implement gender integrated planning
- potential negative impacts of a gender-blind approach
- any opportunities to foster greater gender equality and better climate compatible development outcomes.

Lessons from these examples will serve to draw recommendations for future projects and for policies to ensure that attention to gender equality is not sidelined in climate debate and programming. This is particularly crucial for support to the Lima Work Programme on Gender which aims to promote a greater awareness and consideration of gender issues within climate policy for COP21 and beyond.

References:

P-3341-01

Vulnerability and Adaptation to Climate Change and Extremes: Learning from Women’s Livelihood in the Coastal Area of Bangladesh:

M. Asaduzzaman (1); S. Momtaz (1); M. Sherval (1)
(1) The University of Newcastle, School of Environmental and Life Sciences, Ourimbah, NSW, Australia

Bangladesh is frequently cited as one of the most vulnerable countries to climate change because of its disadvantageous geographic location; flat and low-lying topography; high population density; high levels of poverty; and reliance of many livelihoods on climate sensitive sectors. It is assumed that women are particularly the most vulnerable group affected by the climate change impacts. Rural women are educationally and socially disadvantaged, resulting in economic dependency and vulnerabilities. Growing empirical evidence supports the broad view that women’s overall lower access to assets and services, and voice makes women more vulnerable than men to the effects of climate change and natural disasters (World Bank, 2011). This study particularly examines the context of vulnerabilities of women in the disaster prone areas of Bangladesh to climate change and extremes on women’s livelihood, and the adaption approaches that are followed by the women in response to climate change and extremes. The study was conducted following questionnaire survey methodology, focus group discussion, and key informants’ interview in Shyamnagar upazila (sub unit of district) of Satkhira district. Shyamnagar is the most southern upazila of this district, and the Sunderban laid down in the major part of this upazila. The upazila occupies about 2000 km² area including 1630 km² forest area. The upazila consists of 13 unions (lower administrative unit), and the average population of each union is 24137 (Banglapedia, 2011). This area is situated in the most southwest part of the country, and widely exposed to the Bay of Bengal. The salinity, sea level rise, recurrent flooding, storm surge, cyclone, increased temperature all these climate change impacts are prominent there. This area is also known as the most affected area by the severe catastrophic event ‘cyclone Aila’. During the cyclone Aila in 2009, this upazila was severely affected, almost 100 percent of the households were affected and their livelihoods were lost (UNDP, 2009). The sustainable livelihood framework (SLF) has been applied to analyse the data of the present study. Sustainable Livelihoods Approach serves as an instrument for the investigation of poor people’s livelihoods, whilst visualising the main factors of influence. The result shows that several extreme climate change events are simultaneously affecting this area increasingly for decades. These include salinity, frequent occurrence of disasters (e.g. cyclone), extreme weather condition (e.g. high temperature), water logging, flood, and sea level rise. Almost 100 percent of the respondents in personal interviews and focus group discussions identified these observations about climate change effects over time. The major effects they identified are income loss (95%), damage of livestock and poultry (80%), infrastructural damage (95%), and health damage (65%). Women are particularly affected as they have less income opportunity, facing health problems, food deficiency, malnutrition, and drinking water. Moreover, women are particularly vulnerable to climate change impacts since they have less mobility and less education due to social and religious norms. The absence of empowerment restricts women to take decision in any kind of natural and other events. Their options for adapting with climate change effects are also very limited which put them in a very insecure position. The common adaptation practices they follow are reduce food intake (90%), selling of assets (80%), receiving credit (98%), using saving (100%), seek alternative livelihood (95%), and use of social cards (92%). The adaptation options are mostly temporary and do not ensure the sustainable livelihood of women. They are struggling to adapt with the climate change scenario yet they have to do a responsible job for their entire family. In practice, concerted efforts from all concerned are required both at the national and the grass–roots levels to uphold the present distressed condition of women in the study area and to get adapted them in the ongoing challenges of climate change.

P-3341-02

What does it take to see transformative adaptation? Evidence from sub-Saharan Africa

Q. Bernier (1); P. Kristjanson (2); R. Meinen-Dick, (1)
(1) IFPRI, Washington, DC, United States of America; (2) ICRAF, Washington, DC, United States of America

Throughout sub-Saharan Africa, men and women are already adapting to climate change. However, these changes are often small, incremental changes that
modify existing practices, such as modifying planting dates or changing crop varieties (Twyman et al. 2014). Encouragingly, we do see some farmers taking up what we term transformative practices – practices that contribute to diversified livelihoods, aim to buffer the household against climate changes, increase assets, and have a longer-term time horizon, but also require investments of time, labor, or cash. Transformative adaptations are both technological and behavioral and may require an adjustment in how resources are allocated, changing priorities and norms (Kate, Travis, and Wilbanks 2012). These transformative adaptations face significant barriers, including uncertainty in climate changes, perceived costs, and institutional and behavioral barriers (ibid). Using a data set collected under the Climate Change, Agriculture, and Food Security Research Program of the CGIAR, this paper analyzes the social, behavioral, and institutional determinants of transformative adaptations in Kenya and Uganda, and Senegal, including perceptions and experiences of climatic risk and shocks, and identifies differences between men and women in terms of developing and promoting transformative adaptations. It will be important for practitioners and policymakers seeking to identify barriers and manage tradeoffs in adaptation options at individual and household levels, as well as ensuring that both men and women have the capacities and resources to adapt to long-run climate change. P-3341-03

Rebuilding Home-Women's Informal Participation in the Post-disaster Reconstruction and Recovery in Rural Areas, Sichuan, China

C. Hou, (1) ; H. Wu (1)
(1) Sichuan Agricultural University, School of architecture and urban–rural planning, Dujijiang, Sichuan, China

The vulnerable population, such as females, seniors and youths, is possible to be hit the hardest by the climate changes. The capacity and their response towards climate changes are much lower than other groups. In the rural area of Sichuan, China, due to the fact that the adult men are usually migrant workers in the urban area and leave their wives, parents and childrens as the main residents in the local rural area. Hence, facing the extreme events (such as flood, landslide, earthquake, etc.) caused by the climate changes, the adult women play a key role in the reconstruction and recovery issues after those crisis’s. According to the Chinese governance, however, the different levels of government conduct almost all of the reconstruction reconstructions. This kind of government-led model extremely limits local inhabitants' participation in the process of reconstruction and recovery and most local dwellers could be only informally involved into this process. Therefore, under this unique situation, this paper examines how the local adult female residents’ informal participation contributes to post–disaster reconstruction and recovery. Conducting the in-depth interviews with adult women and their childrens in three different locations and at the same time to train and sensitize those who are slow to adopt this good practice management of natural resources such as trees. P-3341-05

Women's Adaptive Innovations in Land and Water Management under Climate Change in Himalaya: An Illustration of Gender Mainstreaming in Climate Change Adaptation in Marginalized Mountain Environment

B. Joshi (1)
(1) Government Post Graduate College, Geography, Rudrapur, Uttarakhand, India

In Himalaya, constraints of terrain and climate impose severe limitations on carrying capacity of natural systems and productivity of resources as well as on efficiency of infrastructure and services. As a result, subsistence agriculture constitutes main source of rural livelihood for more than 75% population even though the availability of arable is severely limited and agricultural productivity is low. Owing to the constraints of subsistence agricultural economy and lack of other viable means of rural livelihood, a large proportion of youth male population out–migrates the region in search of livelihood and employment. Consequently, women have become ‘primary resource developers’ and ‘backbone of mountain agricultural economy’, and this region has been a flag-bearer of process of natural resource development in Himalaya. During recent years, a variety of changes have emerged in traditional agro–ecosystem in response to population growth, rapid urbanization and economic globalization resulting into depletion of natural resource base and land use intensifications. Moreover, climate change has stressed traditional agricultural–system through rise in temperature, changes in precipitation pattern and increased frequency of extreme weather events increasing vulnerability of large population, particularly the poor and marginalized to food and livelihood insecurity. Women, experience these changes differently and disproportionately and respond in varying manner because of socially constructed gender relations. However, feminization of agriculture facilitated women to develop crisis knowledge in the promotion of sustainable development at local level: Bockle, Sangere–Paul; Ndagm–Baba, Sangere–LANAVET and Sangere–Gal. Among other activities, trainings in the construction and use of improved wood burning stove has been a flagship activity.

A total of 278 people were trained theoretically and practically on improved stove manufacturing technics: Ndagm–Baba: 40 people (35 women 5 men), Sangere–LANAVET: 69 people (60 women +9 men), Sangere–Gal: 60 people (57 women 3 men), Bockle: 55 people (54 women +1 men) Sangere–Paul: 54 people (49 women 5 men). The great campaign of improved wood burning stove construction yielded 263 cookstoves. Ndagm–Baba (36) Sangere–LANAVET (65) Sangere–Gal (55) Bockle (54) and Sangere–Paul (53).

Indeed, it should be noted that 85% of the trainees are now use improved stoves. The use of these stoves have a positive impact on climate change in these localities as the people who use them save half of the wood needed for cooking their meals. The people who use these stoves save half of wood needs for cooking. In addition, this reduction on wood consumption thus shows an interesting decrease of pressure on the trees in these targeted communities. Similarly, say the past, the use of improved wood burning stove has positive health impacts and some family expenses related to the acquisition of wood and cleaning cooking pots.

Project sustainability is ensured by the ownership communities through the Environmental Watchdog Committee (EWC) and organized the improved wood burning stove construction sessions to improve the respondents at different locations and at the same time to train and sensitize those who are slow to adopt this good practice management of natural resources such as trees. P-3341-04

Poverty-Environment mainstreaming role of improved stoves in the fight against climate change

T. Jean Michel (1)
(1) Environment Recherche developpement (ERD), Yaoundé, Cameroun

As part of improving the living conditions of local populations and promoting environmental education, Environment Research Development (ERD) organization with assistance from GEF Small Grants Program realized in 18 months, a pilot project to fight against the effects of climate change. The project was oriented towards school children in their campuses as part of their initiation to trees planting, and to the population of the five target areas the promotion of sustainable development at local level: Bockle, Sangere–Paul; Ndagm–Baba, Sangere–LANAVET and Sangere–Gal. Among other activities, trainings in the construction and use of improved wood burning stove has been a flagship activity.

A total of 278 people were trained theoretically and practically on improved stove manufacturing technics: Ndagm–Baba: 40 people (35 women 5 men), Sangere–LANAVET: 69 people (60 women +9 men), Sangere–Gal: 60 people (57 women 3 men), Bockle: 55 people (54 women +1 men) Sangere–Paul: 54 people (49 women 5 men). The great campaign of improved wood burning stove construction yielded 263 cookstoves. Ndagm–Baba (36) Sangere–LANAVET (65) Sangere–Gal (55) Bockle (54) and Sangere–Paul (53).

Indeed, it should be noted that 85% of the trainees are now use improved stoves. The use of these stoves have a positive impact on climate change in these localities as the people who use them save half of the wood needed for cooking their meals. The people who use these stoves save half of wood needs for cooking. In addition, this reduction on wood consumption thus shows an interesting decrease of pressure on the trees in these targeted communities. Similarly, say the past, the use of improved wood burning stove has positive health impacts and some family expenses related to the acquisition of wood and cleaning cooking pots.
change and assessing its impact on their role in decision-making and empowerment in agricultural resources and assets and reducing gender gap with case illustration of Kumaon Himalaya in India. The study employed comprehensive socio-economic investigation techniques and comprehensive field data collection methods, and gathered 2197 households in 62 villages using exclusively framed schedules. Results indicated mountain women make use of their critical traditional knowledge and experience in household management and adapting their agricultural and food systems to climate change. It was observed that: (i) women in 27% villages replenished water sources employing traditional water conservation practices; (ii) 32% women changed crop production pattern, (iii) women in 25% villages developed indigenous rainwater harvesting system; (iv) 21% women adjusted crop–rotation; and (v) 27% women relocated agriculture; (vii) 55% women traded with management of land and water resources; and (vii) 37% women are now solely responsible for utilization, processing and marketing of their agricultural products. It was observed that women’s innovative practices emerge from their collective management of the variegated actors and groups in the context of climate-smart agriculture in Uganda and Tanzania and what are the perceived problems and potential solution. The implications of the differences between men and women for adaptation, what men and women can do best to enhance adaptation and how men and women are presented.

P-3341-08
Engendering climate smart agricultural innovations in East Africa

M. Nyasimi (1) ; R. Aura (2) ; M. Phiri (3) ; C. Mungai (1)
(1) Climate Change Agriculture and Food Security, East Africa, Nairobi, Kenya; (2) Egerton University, Faculty of Law, Nakuru, Kenya; (3) COMESA, Climate change, Lusaka, Zambia

Gender differences amongst African societies persist particularly in social, cultural and economic roles and responsibilities, access to information and agricultural inputs. Long-term climate change in Africa will have an impact on food security and incomes, and this is likely to have ramifications for gender relations. Studies have shown that gender in conjunction with other factors such as age, wealth, religion and class determines the ways in which the changing climate is experienced. This is particularly visible in more extreme weather events and climate related disasters in juxtaposition with socio-economic, institutional, cultural and political factors tend to intensify existing gender inequalities and responses to climate change in the agriculture sector. In East Africa women make up a large number of the poor in communities that are highly dependent on agriculture for their livelihood and are disproportionately vulnerable to climate change. Their limited access to resources and decision-making processes further exacerbates their vulnerability to climate change.

Against this backdrop, a study was conducted in eastern Africa with the aim of contributing new knowledge on how men and women adjust their livelihoods and coping strategies at individual, household and village level.
in response to climate risks. Using integrative gender sensitivities and methods, an exploratory qualitative research study was carried out. The objectives of the study were a) to characterize gendered climate risks over the past five decades, b) to identify the coping strategies that men and women farmers utilize in order to ensure a measure of food security in response to climate variability, c) to understand the resources available to men and women and the decision making processes utilized, and d) to identify the institutions that support women and men's decision making with regard to climate, agriculture and food security.

Two hundred farmers, half of whom are women were interviewed and 5 focus group discussions held. Research findings show that women perform 65% of off–farm work during drought because only a few of them have property rights (23%) and cannot access any household goods to fill in the food shortage gaps. In terms of perceived changes in weather-related shocks over the last fifty years, more women than men report having observed floods, erratic rainfall and droughts.

The study shows that both genders are adapting to changing climate, and their changes are seasonal rather than transformational. 64% of men and 57% of women reported to have made changes in their agricultural, livestock or livelihood practices in response to the climate risks. Most reported that they grew a new crop, and just a few of them reported constructing water pans to store runoff and for use during drier periods, selling baskets and ropes, altering crop varieties and planting date, and changing cropping patterns. The increasing extent and pace of climate-induced disasters, but also the increasing patterns of migration of male family members. Most women stay behind, usually with children and other members of the family, and take care of the household and children. The study shows that women are left behind family members feel insecure and face many problems including decision-making. The workloads on the female members also increase accordingly. The adaptive capacities of individuals greatly depend on income, education, health and access to natural resources. Scarcity of food can worsen a woman's nutritional status due to her marginalization within a household. Also, as women are mainly responsible for gathering water for the household, paucity of water might increase the burden on women. The impact on women is likely to be worse in developing countries like Bangladesh because of the deepening economic and social gender divide. It was found that women, mostly living alone with children and other female members and in–laws face adversity on a day–to–day basis. In most cases it was found that the male members were unable to send money back to their households, leaving the women to find any means of survival during these periods of migration. In some situations, women were being locked down upon by the other members of the society due to the absence of their male family members, some reported harassment and assault. In some regions, women living without their male family member have become targets and thieves are targeting their households. Still existing social norms and practices across the country lead to the discrimination of women and their rights, which are only exacerbated during times of male migration. On top of unemployment, stress, violence, and taking care of children, women who can find employment often have unstable income with some women reporting an increase in physical, emotional and mental stresses. Moreover, women eat less and work more, either because

P-3341-10

How Climate induced male migration critically affects women left behind?

MG. Rabbani (1) ; ZM. Khan (1)

(1) Bangladesh Centre for Advanced Studies (BCAS), Dhaka, Bangladesh

Cyclones, floods and droughts have been on the rise in both intensity and frequency over the last decades, leaving many citizens with few or no options to earn an adequate living to sustain themselves and their families in Bangladesh. As a result, migration has been a common phenomenon, large numbers of people, mostly men, travelling to other regions in search of a better life and livelihood. The female population in areas of Bangladesh not only have to cope with all of climate change-induced disasters, but also the increasing patterns of migration of male family members. Most often women stay behind, usually with children and other members of the family, and take care of the household and children. This paper is based on a study conducted in 40 villages of 10 out of 64 districts in Bangladesh with support from UN Women and Norad.

The main objective of the study was to explore how climate induced migration of male members affect the women left behind. The study interviewed 40 local women (female members from each village—two local government representatives and two community representatives) from the climate vulnerable districts. The women were selected from the households from which at least one male member migrated mainly because of climate-induced hazards e.g. cyclone, increased tidal surge, salinity intrusion in surface water and soil, drought, water logging caused by tidal surge/excessive rainfall etc. Secondly, 20 Focus Group Discussions were conducted to meet the objective of the study. The secondary literature were collected and reviewed to determine tools and complement and verify the study findings.

The study denotes that migration of a male member from a family has various social, economic and mental impacts on the female members of the family. The women left behind family members feel insecure and face many problems including decision-making. The workloads on the female members also increase accordingly. The adaptive capacities of individuals greatly depend on income, education, health and access to natural resources. Scarcity of food can worsen a woman's nutritional status due to her marginalization within a household. Also, as women are mainly responsible for gathering water for the household, paucity of water might increase the burden on women. The impact on women is likely to be worse in developing countries like Bangladesh because of the deepening economic and social gender divide. It was found that women, mostly living alone with children and other female members and in–laws face adversity on a day–to–day basis. In most cases it was found that the male members were unable to send money back to their households, leaving the women to find any means of survival during these periods of migration. In some situations, women were being locked down upon by the other members of the society due to the absence of their male family members, some reported harassment and assault. In some regions, women living without their male family member have become targets and thieves are targeting their households. Still existing social norms and practices across the country lead to the discrimination of women and their rights, which are only exacerbated during times of male migration. On top of unemployment, stress, violence, and taking care of children, women who can find employment often have unstable income with some women reporting an increase in physical, emotional and mental stresses. Moreover, women eat less and work more, either because

P-3341-09

Adaptation and resilience of farming households to climate change using their indigenous knowledge: A study of the Niger Delta region

CD. Onyige (1)

(1) University of Port Harcourt, Sociology, Port Harcourt, Rivers State, Nigeria, Federal Republic of

The Niger Delta region in Nigeria is home to over 30 million people (Nigerian Population Commission, 2009), the bulk of which live in the rural areas. This region is characterized by intense poverty, and has suffered from a long history of socio-economic neglect and environmental degradation caused by tidal surge/excessive rainfall etc. Secondly, 20 Focus Group Discussions were conducted to meet the objective of the study. The secondary literature were collected and reviewed to determine tools and complement and verify the study findings.

The study denotes that migration of a male member from a family has various social, economic and mental impacts on the female members of the family. The women left behind family members feel insecure and face many problems including decision-making. The workloads on the female members also increase accordingly. The adaptive capacities of individuals greatly depend on income, education, health and access to natural resources. Scarcity of food can worsen a woman's nutritional status due to her marginalization within a household. Also, as women are mainly responsible for gathering water for the household, paucity of water might increase the burden on women. The impact on women is likely to be worse in developing countries like Bangladesh because of the deepening economic and social gender divide. It was found that women, mostly living alone with children and other female members and in–laws face adversity on a day–to–day basis. In most cases it was found that the male members were unable to send money back to their households, leaving the women to find any means of survival during these periods of migration. In some situations, women were being locked down upon by the other members of the society due to the absence of their male family members, some reported harassment and assault. In some regions, women living without their male family member have become targets and thieves are targeting their households. Still existing social norms and practices across the country lead to the discrimination of women and their rights, which are only exacerbated during times of male migration. On top of unemployment, stress, violence, and taking care of children, women who can find employment often have unstable income with some women reporting an increase in physical, emotional and mental stresses. Moreover, women eat less and work more, either because
they cannot earn enough, or because of social norms and processes that forces them to stay in their families first. With a lack of social support mechanisms and adequate policy environment to protect women's rights, the process of male migration due to climate change may in fact contribute to a worsening situation for gender inequality.

Yet, in spite of the negative impacts of migration in most cases, if not all, migration can help families to stay afloat and in even improve overall financial conditions. Thus, in a disaster stricken country like Bangladesh, migration can be a negative and positive approach to dealing with climate change. Women's empowerment and indigenous rights have been widely embraced as foundational principles of international social and economic development for several decades in recognition of the transformative potential for achieving intertwined goals of human rights and sustainable development. Programs to address climate change are no exception, and the growing urgency of finding means to mitigate its potential ravages requires finding effective ways to fully incorporate women and other marginalized groups into these efforts. A growing body of literature documents the importance of gender justice to this effort, yet achieving it often remains illusive. A prime example is found in REDD/REDD+ projects, the United Nations collaborative program for Reducing Emissions from Deforestation and forest Degradation. As a key initiative for conserving forest resources and associated ecosystem services, it is equally important for goals of sustainability, gender equity, and empowerment of marginalized groups.

According to the UN, REDD “is an effort to create a financial value for the carbon stored in forests, offering incentives for developing countries to reduce emissions from forested lands and invest in low-carbon paths to sustainable development. ‘REDD+’ goes beyond deforestation and forest degradation, and includes the role of conservation, sustainable management of forests and enhancement of forest carbon stocks” (http://earthtrends.wri.org/aboutredd/tabid/102614/default.aspx, accessed May 25, 2014). These projects have been initiated in a variety of countries and regions with significant forest resources and forest resource loss, and in even improve overall financial conditions. The goal of REDD/REDD+ is to encourage developing countries to conserve and maintain their forest resources by making standing forests more profitable than felled forests. In addition to creating an economic incentive for the conservation of these forests, REDD/REDD+ was envisioned as catalyst for addressing social issues facing these countries, including poverty and inequality. In theory, REDD/REDD+ projects must both comply with gender mainstreaming practices and benefit indigenous communities. A major criticism of REDD/REDD+ is that, as a neoliberal policy that prioritizes economic growth, the principles of gender mainstreaming and community inclusion remain lofty policy ideals rather than on-the-ground reality. Due to limited capacity for monitoring and evaluating projects, as well as on-going corruption and mismanagement, the effectiveness of REDD/REDD+ is often seen as disempowered groups, including women and indigenous communities, will be further marginalized through the implementation of REDD/REDD+, despite stated policies to the contrary.

This paper is based on the comparative research on challenges and progress toward effective gender equity and mainstreaming as well as involvement of indigenous communities in REDD sites in Indonesia and the Philippines. We focus on these two countries because of the similarities in the level of economic development and the characteristics of the ongoing REDD/REDD+ projects. We interviewed scholars, community members, policy analysts, and activists who have been involved in designing and implementing various REDD/REDD+ programs in these two countries. The results highlight the development and obstacles of these two resource rich countries in implementing REDD/REDD+ programs.

P-3342-01

Adaptation pathways for inland aquaculture in northern Thailand

L. Lebel (1)

(1) Chiang Mai University, Unit for Social and Environmental Research, Chiang Mai, Thailand

Background: Aquaculture systems are likely to be impacted by changes in climate; not all impacts are expected to be negative, and in some situations aquaculture may become an alternative to land-based agriculture. Most aquaculture systems, however, are vulnerable to water scarcity, and their interactive effects on water quality, as well as extreme floods, storm surges and sea-level rise. Inland aquaculture in Northern Thailand is important for livelihoods and a significant economic activity that is sensitive to climate variability and water management. Aquaculture production for commercial purposes, as well as direct consumption, takes place in earthen ponds, and in cages in rivers and reservoirs. Adaptation pathways with inland aquaculture in Northern Thailand are needed which allow reasonable actions to be taken now, for instance, to strengthen management of climate–related risks, while also leaving flexibility in households, and the sector as a whole, for adjustment of strategies in the future.

3342-Poster Presentations

P-3342-11

Gender Justice and Sustainability in REDD/REDD+ Climate Change Projects in Indonesia and the Philippines

E. Wornell (1) ; A. Tickamyer (2) ; S. Kusujiarti, (3)

(1) The Pennsylvania State University, Rural Sociology and Demography, Pennsylvania, United States of America; (2) Penn State University, Agricultural Economics, Sociology, and Education, University Park, PA, United States of America; (3) Warren Wilson College, Sociology, North Carolina, United States of America

Purpose: The purpose of this paper is to report on the findings of the AQUADAPT research and assessment process to: (1) identify the key sensitivities of inland aquaculture systems to climate-related risks; (2) assess farm household efforts to manage those risks under current climate variability; and (3) apply this understanding to identify strategies for building the resilience of aquaculture social–ecological systems, and in developing plausible, context-specific, adaptation pathways for aquaculture in northern Thailand.

Methods: Combination of new research, review of past work, expert synthesis and participatory, local assessments, was used to answer four key questions: four future scenarios – wetter, drier, more seasonal, and less seasonal – were constructed, based on a set of downscaled climate projections for 2040-2059, to capture key uncertainties in future climate in northern Thailand. Scenarios were developed for water and fish demand to complement the four for climate yielding a total of 16 combinations or final scenarios. These 16 scenarios were used to explore the robustness of options and determine a set of adaptation strategies at different levels, and construct alternative adaptation pathways.

Results: Adaptation measures or strategies are being pursued, or have been proposed, at the farm (household), watershed (community) and sector (national) levels. At farm level the focus is on rearing practices and business management. At the household level the focus is on sharing of information relating to building alternative livelihoods, and the formation of fish farmer’s groups to influence water resources management. At the sector level insurance, voluntary standards, and investments in research and development
are frequently recommended. Examples of measures emphasizing the management of fishery resources, as well as broader strategies for building resilience of the aquaculture social–ecological system, were found at each level. The emerging adaptation pathways for aquaculture include some contradictory elements, reflecting uncertainties about effectiveness, differences in development ideologies and expectations for the sector. Either way, it is clear that adaptation strategies need to be recognized as successful efforts to improve the self-organization and innovation. At the same time there are widespread concerns about the availability of suitable quality water for production in the future, underlying the importance of quality of inputs needed for adaptation and the practices to adaptation. Public sector support for building climate resilience of aquaculture industry in northern Thailand should: (1) strengthen the knowledge foundations for adaptation; (2) support improvements in the management of climate–related risks under current climate variability; (3) improve water and watershed management; and, (4) acknowledge in policy and planning that adaptation will need to be context specific.

P-3342-02
Coastal hazards and climate change in the Loyalty Islands (south-west Pacific), multidisciplinary approach

M. Le Duff (1); M. Allenbach (2); P. Dumas, (1); O. Cohen, (1); T. Hibouian, (3)

(1) University of New Caledonia, Cnep, Noumea, New Caledonia; (2) Loyalty Islands, New Caledonia; (3) University of New Caledonia, Ppm, Noumea, New Caledonia.

This communication presents the objectives and preliminary results of a study concerning the evolution of atoll’s coastlines with climate changes and their social involvement. This work is carried out in the southwest Pacific and is funded by the Government of New Caledonia, the European Union (Program INTEGRÉ) and the French Ministry of overseas territories (Program MOM). In order to provide some guidelines for the Ouvea Loyalty Islands of New Caledonia, we focus on the understanding of the coastal environment in costal risks management, a dual methodological approach is undertaken to understand the complexity of the relationships between social and physical processes associated to coastal evolution of atolls with climate changes.

Concerning the physical process, the geomorphologic vulnerabilities of islands are first studied in relatively large spatial and temporal scales, using diachronic analysis of aerial and satellite imagery of Ouvea Island over the last 60 years. At the same time, a monitoring of current coastal sediment dynamics is realized on the sandy shores of the Island. A continuing survey over two years is planned on the main beaches of the Island, which strongly affect the local erosion processes. The first component of this survey is to obtain in-situ data concerning the impacts of repeatedly evolving phenomena such as cyclones, tsunamis, tornadoes, or blows. As an example, we will present a qualitative and semi-quantitative analysis of climate impacts on the evolution of Ouvea Island after the passage of the cyclone PAM (Category 5, 894 mbar, mid-March 2015) that hits the Vanuatu archipelago, which is close to Loyalty Islands. The second component of the study is based on two approaches: (1) various specific and expensive methods (DGPS, Photo restitution from aerial surveys by UAV) and (2) less sophisticated methods (up to the frame, site level) less expensive but less expensive and without requiring specific technical skills, allowing the involvement of local people. In a Pacific area bereft of resources, the purpose is to provide methods to survey environmental phenomena affecting remote and isolated islands and to create a database of historical archives. The aim is to better understand the current evolutions of the region from the perspective of the dynamics of the hazard (time, power, participants) by providing additional analysis of documents and data, now available to the Caledonian Weather Service. Moreover, we will address vulnerability issues (human, environmental, economic) and capacity and / or resilience strategy developed in the last decades and over 150 years. Mastering these issues related to the past and present social and climate change will help to better understand the abilities of atoll’s stakeholders in terms of adaptation and limitations to which these strategies will be faced by the end of the century. A database of more than 285 extreme weather events that impacted the New Caledonia since 1830 has been established and is being analyzed. The case study of the tsunami of March 28th 1875 to determine the exact impact of this major event on the Loyalty coastlines will be presented.

In conclusion, we point out the importance of developing integrated, holistic approach of coastal dynamics, both from physical and socio-cultural perspectives, and to provide the best adaptation strategy regarding the evolution of atoll’s coastlines with climate changes.

P-3342-03
Balancing Consumers’ Satisfaction with Water Quality and Reducing Energy Use: A Case Study in Japan

V. Shinde (1); N. Hirayama (2); S. Itoh (3)

(1) Asian Institute of Technology, Water Engineering and Management, Bangkok, Thailand; (2) National Institute of Environmental Studies, Centre for Materials Cycle and Waste Management, Tsukuba, Japan; (3) Kyoto University, Environmental engineering department, Kyoto, Japan

Japan ranks fifth among the countries that produce the highest Greenhouse gases (GHG) emissions (UNFCC, 2012). In light of the Fukushima nuclear disaster in 2011, the country has revised its GHG reduction targets to 3.5% in 2020 from 2005 levels. In addition, the shutdown of atomic power plants leading to rise in the use of fossil fuels, which makes this reduced target also daunting. Although the water supply sector in Japan accounts for less than 1% of the total emissions, it is important for this sector to reduce energy use since it is only through collective contributions of all sectors that the GHG reduction vision can be achieved.

Japan has a well-developed water supply system and over the years, there has been a systematic progress in the nature and type of water treatment. However, in recent years the consumers’ expectations of water quality in Japan have been on the rise. A survey conducted in Osaka by the authors in 2007 revealed an increase in the number of consumers who plan to switch or change the current water treatment provider. However, the increasing demand for such processes is high. Hence, it is difficult for the utilities to meet the GHG emission reduction targets as well as maintain/improve CSWQ. There is a need to arrive at an optimum balance between the two, which is the objective of this study.

The rationale behind the study’s methodology is to link the energy source with CSWQ so that when scenarios of reduction in energy use are considered, corresponding changes in the CSWQ can be observed. Data required for this study was procured from Kobe City Waterworks Authority (KCWA), Japan. The study involved three distinct stages:

(a) Evaluating CSWQ: An internet based questionnaire survey was used to assess the CSWQ, in which respondents were asked to evaluate eight items. Factor Analysis was then performed to quantify CSWQ, as presented in...
Fugitive methane emissions from Indian coal mining and handling activities: Estimates and opportunities for its utilization to generate clean energy

AK. Singh (1); J. Kumar (1); A. Garg (2)
(1) CSIR–Central Institute of Mining and Fuel Research, Methane Emission and Degasification Division, Dhanbad, Jharkhand, India; (2) Indian Institute of Management Ahmedabad, Public systems group, Ahmedabad, India

Fugitive methane emissions from coal mining and handling activities are a prominent source of greenhouse gas (GHG) emissions from India. The total GHG emissions from India’s energy sector were around 1.4 million Gg-CO2 equivalent in 2007, out of which ~34,000 Gg-CO2 emissions were from fugitive emissions of coalbed methane [1]. The fugitive emissions estimated mainly by using India-specific emission factors developed by CIMFR suggest that Methane emitted annually to the atmosphere from Indian coal mining and handling systems has gone from 0.555 Tg for the year 1991 to 0.772 Tg in the year 2010.

The Integrated Energy Policy of the Government of India projects that coal consumption in India shall grow at the rate of 6 per cent per year. The current production is projected to reach 630 million tonnes in 2015 and around a billion ton by 2020. Taking the future projections of coal production and consumption, we also project the future trend of methane emissions from coal mining and handling activities of India.

The methane generated from coal mining and also as coalbed methane has the potential to serve as a clean fuel. There are several opportunities for this methane to play its role in the meeting the energy demands of India. This is more so relevant with the Indian government showing signs of encouraging clean coal technologies (CCTs). There are several mechanisms for this in the Indian context. This includes:

1. Coal Mine Methane (CMM): We completed a project recently funded by the US EPA for feasibility of CMM in three major coalfields in eastern India, viz. Jharia, Bokaro and Raniganj coalfields. At first glance, it appears that Kalidaspur and Chhusik collieries in the Raniganj Coalfield, Murulidih, Amlabad, Sudamdh and Parbatpur mines in the Jharia Coalfield and Jangnad and Sawang collieries in the East Bokaro Coalfield are promising sites for CMM recovery. The measurements and potential for CMM in these mines shall be talked about in details in this paper.

2. Ventilation Air Methane (VAM): CIMFR, along with Southern Illinois University at Carbondale completed a joint project on VAM utilization in India. We have made some assumptions with the (½) x 10 model, wherein it is assumed that fifty per cent of the CMM resource boundary can be recovered in 10 progressive years. Our calculations suggest that installation of just two rotary kilns, revenue of US$ 2.8 million can be generated in two years. The details about VAM opportunities shall be covered in detail.

3. Abandoned Mine Methane (AMM): There has not been any effort to identify the abandoned mines and quantify the AMM resource in India. It is thus imperative to undertake a study to evaluate the AMM resource potential of the country before any utilization potential is planned.

4. Coalbed methane (CBM): An estimated potential of 400 BCM of coalbed methane exists in three states alone (Jharkhand, West Bengal and Chhatisgarh). Efforts are already underway for exploitation of CBM in India [2]. Such mechanisms, if employed shall serve as a useful tool to reduce the existing GHG emissions as well as to find new avenues of cleaner energy in India. This is even more important because India is naturally devoid of high natural gas reserves and such mechanisms can help in bridging the gap for this.

It is hoped that this paper shall present a useful analysis for policy makers and the industry to get an overview of the scientific status for clean energy in India through methane emissions from coal mines.

References:
issues as the risk of slow onset events, economic and non-economic L&D, CCI on most vulnerable, approaches to slow onset and extreme weather events, integrating slow onset and extreme events into climate resilient development processes, and how climate change is affecting patterns of mitigation, displacement and human mobility.

The presentation will provide an overview of how APN’s Climate Adaptation Framework is responding to climate change challenges by providing a flavour of the fifteen projects currently underway in the Asia-Pacific region, all of which are undertaking regional-based research activities and/or capacity building with specific foci on linking CCI, DRR and L&D. The session will then go into more detail by providing information and important outputs to date from projects being conducted in South and Southeast Asia.

Topics covered will include:

1. Major low-lying coastal cities Southeast Asia that are severely impacted by severe flood events and how sectors, such as agriculture, in these areas will face increased challenges as impacts of extreme events are projected to worsen;

2. Solutions-oriented research outputs of how best to integrate climate change adaptation with disaster risk, particularly for slow onset events; and

3. Work being undertaken to address the important need to integrate adaptation to climate change into development planning in policy- and decision-making communities.
ABSTRACT BOOK
International Scientific Conference    7-10 JULY 2015    PARIS, FRANCE

ORAL PRESENTATIONS

K-4401-01
Sustainable Development Goals, Science and Politics
C. Körösi, (1)
(1) Office of the President of the Republic of Hungary, State secretary, director for environmental sustainability, Budapest, Hungary

Based on his experience as co-chair of the Open Working Group (OWG) on Sustainable development goals (SDG), Mr. C. Körösi will be talking about the lessons for the SDGs learnt from the OWG negotiation process, especially focusing on science policy interface. This will include his personal reflection of the OWG process in terms of science and policy, and personal views on how science could contribute to the post-2015 development agenda and their implementation process.

O-4401-01
Governance through Goals: Options and Opportunities for the SDGs
N. Kanie, (1)
(1) Keio University, Professor, graduate school of media and governance, Tokyo, Japan

Two unanticipated consequences in formulation of the Sustainable Development Goals (SDGs) from the outcome of Rio+20 are of great importance for governance for sustainability: that the SDGs would link sustainable development to the continuation and strengthening of the Millennium Development Goals (MDGs) in a single agenda at the centre of a post-2015 development framework; and that their negotiation would entrench "goal-setting" as a dominant strategy in global governance. This single, goal-oriented agenda, is not simply a continuation of unfinished elements of the MDGs, but it aspires to build from their central mission of poverty eradication and social inclusion a universal, integrated agenda that also responds to growing social and planetary complexity in the twenty-first century. While the very notion of negotiating a set of SDGs is remarkable in its own right, they mark an equally significant shift in global governance strategy: from norm promotion and rule-making to goal-setting.

O-4401-02
Allocation of resources to LDCs for adaptation - A climate vulnerability index
P. Guillaumont (1)
(1) FERDI – Université d’Auvergne, Clermont Ferrand, France

An amount of resources, still to be determined, will be made available for the adaptation to climate change in developing countries, in particular to Least Developed Countries. Since these countries are not responsible for the global impact of climate change, it seems equitable to allocate concessional resources mainly according to their vulnerability to climate change (beside their low level of income per capita). For doing that we suggest to use a physical index of vulnerability to climate change reflecting the likely shocks resulting from climate change and faced by each country independently of its will, what means an index not taking into account any policy factor of resilience. Such an index has been built on an exploratory basis at FERDI with this aim in view. Complementarity and consistency with the allocation of development assistance models using income per capita, structural economic vulnerability and governance indicators as criteria will be also underlined.

O-4401-03
A poverty – adaptation –mitigation window within the Green Climate Fund
S. Mathy (1); O. Blanchard (1)
(1) PACTE, EDDEN, Grenoble, France

The stakes for poverty alleviation and the measures required to avoid unbridled climate change are inextricably linked: on the one hand, climate change may slow down and even reverse trends in poverty reduction; on the other hand trajectories consistent with a 2°C temperature increase require poverty alleviation strategies to integrate the constraint of a low carbon development.

Existing climate funds have failed to target poverty alleviation as a high priority of adaptation strategies. It is important to distinguish adaptation actions that are purely aimed at adapting to impacts of climate change and would not otherwise be initiated, from broader adaptation needs and development-related actions to reduce climate change vulnerability, i.e. actions to reduce the adaptation gap. The existing project-based approach of the Adaptation Fund is more adequate to deal with the first category of adaptation actions, while it is likely that poorer regions and communities need to look more specifically to the adaptation deficit. How can a single financial instrument address both in an optimal manner? So far, all attempts to create aggregated vulnerability indicators relying on a single number have revealed unsatisfactory to determine where available funding should be used in priority, as these indicators lead to contradictory results and often depend on value judgments on which there is no consensus.

Allocation of climate funds focusing on development-related actions to reduce climate change vulnerability requires defining a set of indicators that reflect factors of poverty.

Existing climate funds and the CDM have failed to target poverty alleviation as a necessary component of a low carbon development.

Existing climate funds and the CDM have mainly allocated resources to high-emitting developing countries, or to countries with a rapid growth in their GHG emissions. To maximize the environmental efficiency, climate funds and financial mechanisms favour projects or actions that maximize the quantity of emission reductions. Such indicators are not adequate with poor countries with no mitigation potential relative to a historic reference because the development deficit leads to low initial emission levels.

To favour low carbon development opportunities in poor countries, other indicators than emission reductions relative to a historic reference scenario should be used.

Description of the poverty-adaptation-mitigation window (PAM-W)

To go beyond these obstacles in targeting poverty alleviation as an adaptation strategy and as a component of a low carbon development, we propose to complement the existing adaptation and mitigation windows of the Green Climate Fund (GCF) with a window focusing on synergies between poverty alleviation, adaptation and mitigation.

Actions funded within this window would either be sectoral programs or policies in order to be consistent with the GCF objective of paradigm shift.

A series of macro indicators that reflect factors of poverty would be used for the selection of beneficiaries.

The aid mechanism would be based on national or regional benchmarks reflecting the per capita cost for providing a specific basic need (the cost of providing access to sanitation to one additional person, the cost of providing access to electricity to an additional person).
Part of the funds allocated would be transferred based on the actual implementation of the action. The allocation metric would be the actual net changes in the number of people gaining access to the concerned basic need. Countries would be free to develop their own strategy, and they would have to finance it initially, from domestic resources, existing development aid channels or international private capital.

Given the huge financing needs to address GCF objectives, available financial resources for the PAM–W would be limited and financial modalities within the PAM–W would have to limit windfall profits and to vary according to income categories of countries. Additional conditions could reinforce the appropriation of actions by countries: co-financing for low income countries, private financing for upper-middle income countries.

O-4401-04

SDGs as way to better mobilize funding for climate and for development?

D. Vencatchellum (1)
(1) African Development Bank, Director, resource mobilization and external finance department, Tunis, Tunisia

Based both on his expertise in development Bank economics and on his experience as an economist within a multilateral development bank (the African Development Bank), Dr D. Vencatchellum will present his analysis of how SDGs could help better mobilizing funding for climate and for development, and will also react to the proposals made by other presenters in the panel.

O-4401-05

Raising the ambition: How the global climate agreement can affect the achievement of the Sustainable Development Goals

N. Walmsley (1)
(1) HR Wallingford, Water Group, Wallingford, United Kingdom

N. Walmsley (HR Wallingford), A. Ansuategi (Metroeconomica), P. Grefo (Metroeconomica), V. Houdzen (HR Wallingford), A. Markandya (Metroeconomica), L. Onofri (Metroeconomica), G. Tsarouchi (HR Wallingford) and H. Picot (CDKN)

In the coming year, key decisions will be made on several intergovernmental agendas, including climate change, disaster risk reduction, sustainable development and financing for development. The impacts of climate change resulting from varying levels of ambition over long-term horizons (e.g. to 2050 and beyond) are a current focus of much global research effort. However, little is known about the projected impacts of the climate deal on development in the shorter term.

This paper seeks to fill a knowledge gap by investigating the development impacts projected for varying levels of climate ambition in the 2015 climate deal, as such a deal will necessarily impact on national decision making around resource allocation and development priorities. The Sustainable Development Goals (SDGs) are used as a lens through which to measure and frame the question: How can the global climate agreement affect development in the period to 2030? Using a combination desk study, integrated assessment modelling (IAM) and information from the literature, a subset of the 17 proposed SDGs are assessed according to the projected socio-economic outcomes of binary climate ambition scenarios. Two scenarios are considered: a high ambition agreement (to limit global warming on pre-industrial levels to 2°C) and a low ambition agreement (to limit global warming to 2°C by 2100 on pre-industrial temperatures is essential to have the best chance of achieving the SDGs by 2030).

A high ambition agreement is most crucial to achieving the draft SDGs on poverty (SDG 1), inequality (SDG 10), climate change (SDG 13) and global partnerships for sustainable development (SDG 17).

Country case studies were used to compare and contrast with the above high-level regional findings.

Negotiators and the development community should find the outputs of this research useful to advocate for a stronger climate deal, and to ensure that the SDGs deliver climate smart development in the poorest and most climate vulnerable countries.

P-4401-01

Bottom-up formation and stabilization of a grand climate coalition under rationality

J. Heitzig (1) ; U. Kornek (2) ; K. Lessmann (2)
(1) Potsdam Institute for Climate Impact Research, Transdisciplinary Concepts and Methods, Potsdam, Germany; (2) Potsdam Institute for Climate Impact Research, Sustainable solutions, Potsdam, Germany

After the Copenhagen failure, recent negotiations have seen a shift from the Kyoto top-down agreement to the Durban bottom-up process of national pledges. Economic models had predicted that an effective near-global climate protection “coalition” was likely “unstable”. The public good character of emissions reductions, related positive externalities, and the resulting incentives for noncompliance and freeriding pose difficulties for achieving sufficient international cooperation (Barrett 2005). Although the bottom-up approach may enhance negotiations, Lima has again shown the slow progress and the large uncertainties involved about the process.

In this talk, we present a dynamic and stochastic game-theoretic model of the process of coalition formation and its implications for the prospects and uncertainties of bottom-up climate formation. The assumption of rationality. It includes these novel features: (i) Unlike most existing models, we assume that over time, the major GHG emitting nations can form, grow, merge, shrink, split, or terminate any number of coalitions. (ii) In proportion to bargaining power, players can repeatedly propose changes in the coalition structure, and a proposal will be accepted if it is profitable for the responsible players and not dominated by another move of the same or fewer players. (iii) When assessing profitability, players may farsightedly anticipate later moves to some degree. (iv) Uncertainty about who will propose next leads to unresolvable uncertainty about the sequence of moves (the realised “pathway”), leading to a consistent scenario of different branching pathways and their probabilities. (v) Uncertainty about players’ expectations may lead to the existence of several competing consistent scenarios, each of which represents a different (but common to all players) set of expectations.

Our main findings support the hopes that a bottom-up process may work eventually: (i) for each parameter
setting, there is typically more than one consistent scenario, but in all of them a stable global coalition will be formed eventually. (2) No formed coalition will be terminated later although the model explicitly allows unilateral termination of agreements. (3) Typically, there are several handsful of competing pathways toward global cooperation, and they differ in the number of steps needed and in their allocation of mitigation costs. (4) This path uncertainty is largest in the early steps of the process, whereas typically (a) the most vulnerable nations and those with the lowest mitigation potential ("reluctant" players) exhibit chicken-game-like behavior by trying to delay their own cooperation, in order to free-ride for as long as possible and to achieve a better bargaining position for their later entrance into an existing coalition, while (b) at the same time, the least vulnerable players and those with the highest mitigation potential ("eager" players) compete for an exclusive coalition among many reluctant players a few other eager players, in order to get a higher share of the vulnerable nations' gains from avoided climate change via surplus sharing and to get a higher compensation from them for their mitigation service. (5) Surprisingly, in our model these strategic interactions do however not lead to a stalemate without progress since such a stalemate would not form a consistent set of expectations. (6) Among the alternative consistent scenarios, there is typically one "focal" (Schelling 1960), relatively symmetric scenario in which no player has a considerable advantage, and several asymmetric scenarios in each of which one player is at an advantage.

To complete our strategic analysis, we finally present a strategy by which a coalition of rational players may incentivise compliance with their agreement to make the latter self-enforcing (Heitzig, Lessmann, Zou, PNAS 2011). It consists of a simple temporary redistribution of liabilities in proportion to preceding shortfalls and can be seen as a renegotiation-proof improvement of the Kyoto protocol's noncompliance rules.

P-4401-02

Building an Index of Physical Vulnerability to Climate Change

C. Simonot (1) ; P. Guillaumont (2)
(1) Overseas Development Institute, Climate and Environment Program, London, France; (2) FERDI – Université d’Auvergne, Clermont Ferrand, France

The Index of Physical or Geophysical Vulnerability to Climate Change differs from the other indices on vulnerability to Climate Change by only considering this part of the vulnerability which does not depend on the present policy. To this aim it relies only on physical components likely to reflect an impact of climate change, without any use of socioeconomic data. It is an index of physical vulnerability to climate change, changing only progressively and slowly.

It also differs from other vulnerability indices, both from the more general environmental vulnerability indices, which most often include resilience and policy components, and from the Economic Vulnerability Index (EVI) used by the Committee for Development Policy for the identification of the Least Developed Countries (LDCs). The EVI is related only to physical vulnerability, as the present Physical Vulnerability to Climate Change Index (PVCCI), but it differs from the latter: it covers all kinds of exogenous shocks likely to affect economic growth, it refers to a shorter term horizon and it tries to capture a handicap to economic growth rather than a risk of a change in geophysical conditions. Thanks to these features, the PVCCI, set up at the country level, could be used as a criterion for financial aid and to target international resources available for the adaptation to climate change. It is a relevant criterion precisely because it doesn’t depend on the present policy, and it only gives an indication of the need for adaptation. By the same way the EVI has been proposed as a possible criterion for the allocation of development assistance. The design of the PVCCI draws both from the environmental literature and from the attempt to measure physical economic vulnerability, as it is done by the Economic Vulnerability Index. As an environmental index, the index relies on components reflecting the physical consequences of climate change that can directly affect population welfare and activity, rather than an assessment of their long term economic consequences, which would be debatable. The index relies on eight components, considered as relevant, reliable, and available for the whole set of developing countries and easily understandable, so that the index can be used in a transparent manner. These eight components respectively capture the threats of progressive or cumulative shocks due to climate change and the risks related to the intensification of recurrent shocks due to it.

The PVCCI has been calculated on the basis of data covering the last 60 years for 146 developing countries and territories. Results evidence a high heterogeneity among countries in the level of physical vulnerability to climate change and an important vulnerability of SIDs, even within a same regional area. The high physical vulnerability to climate change of the LDCs and SIDs is highlighted by the index, which emphasizes that countries are already found to have an high economic vulnerability, as evidenced by EVI.

This presentation will draw heavily from a large body of scenario research summarized in Chapter 6 of the Working Group 3 contribution to AR5. Over 1000 new scenarios published since AR4 were collected from integrated modeling research groups, many from large-scale model intercomparison studies and synthesized in WG3. These scenarios provide important information on key questions such as the near-term emissions reductions compatible with meeting long-term goals, the costs of mitigation, and the energy and land system transformations. In comparison to AR4, new scenarios have considered more ambitious climate change mitigation assumptions about technology, and more possibilities for delays in global mitigation and fragmented international action than those published previously.

Drawing on this literature, the presentation will address several questions that provide context for understanding transformation pathways. First, to what degree is it possible to link near-term emissions reductions to the goal of limiting temperature change to less than 2°C? We may assume that we need to consume energy to how we use the land surface. The more ambitious the stabilization goal, the more rapid this transition. Drawing on this line of thought in context is what are meaningful “transformation pathways” towards stabilization; that is, how do we get from here to there? This presentation provides an overview and introduction for understanding transformation pathways to 2°C and other temperature goals.

4402a - Low carbon pathways for staying below 2°C: Global requirements

K-4402a-01

Dr. Leon Clarke
L. Clarke (1)
(1) Pacific Northwest National Laboratory (PNNL), Joint Global Change Research Institute, College Park, MD, United States of America

The long-term goal of limiting temperature change to less than 2°C will require deep reductions in greenhouse gas emissions within a realistic time frame. CO2 emissions, in particular, must eventually be brought to or below zero to meet this or other long-term temperature goals. Emissions reductions of this magnitude will require large-scale transformations in human societies, from the way that we produce and consume energy to how we use the land surface. The more ambitious the stabilization goal, the more rapid the transition. Drawing on this line of thought in context is what are meaningful “transformation pathways” towards stabilization; that is, how do we get from here to there? This presentation provides an overview and introduction for understanding transformation pathways to 2°C and other temperature goals.

ORAL PRESENTATIONS

K-4402a-01

Dr. Leon Clarke

L. Clarke (1)
some key characteristics of transformation pathways that maintain likely temperature change below 2°C. Key characteristics include emissions reductions rates, sectoral emissions reductions, economic costs, and technology transformations. Finally, to what degree can scenarios inform us on which pathways are more feasible than others? Mitigation actions inherently involve a wide range of tradeoffs that link to social and policy objectives such as economic growth, energy and food security, the distribution of economic costs, local air pollution, other environmental factors associated with different technology solutions, and economic competitiveness. All of these linkages will influence the likelihood and feasibility of different mitigation pathways, and assessments of feasibility must, in addition, account for the rapidity at which social and technological systems would need to change to maintain temperature change below 2°C.

K-4402a-02

Staying below 2°C: What are the implications of and requirements for short-term policies?

G. Luderer (1) ; E. Kriegler (1)

(1) Potsdam Institute for Climate Impact Research, Potsdam, Germany

Current efforts to mitigate climate change are not in line with mitigation pathways stabilizing global warming below 2°C in a cost-optimal way. Over the past decade, global greenhouse gas emissions have further increased and are projected to reach 50-59 GtCO2e by 2020. This is much higher than emission levels in mitigation scenarios that assumed comprehensive mitigation action towards 2°C stabilization from 2010. The discrepancy between the long-term ambition of climate policy, i.e. limiting warming to 2°C, and the weakness of mitigation action raises important questions: What are the consequences of delaying comprehensive climate policies? What are requirements for policies and measures to keep the 2°C target within reach?

This presentation will draw on a number of recent studies based on integrated energy–economy–climate models (AMPERE, LIMITS and RoSE multi-model intercomparison projects, as well as single-model studies) to address these questions. There are a number of robust, policy-relevant insights that emerge from these studies about the adverse consequences of a further delay of comprehensive mitigation action:

• Due to the tight constraint on cumulative CO2 emissions implied by the 2°C limit, higher than optimal emissions in the near-term have to be compensated by lower emissions in the long term. This implies a much faster pace of emission reductions in the medium term. Scenarios with high 2030 emission levels feature post-2030 emission reduction rates that are roughly twice as high as those in scenarios with optimal timing of mitigation efforts.

• At the same time, a lack of meaningful mitigation action in the near-term reduces the longer-term mitigation potential. This is due a further lock-in into carbon intensive infrastructure, and insufficient up-scaling of low-carbon technologies. As a consequence, the costs of putting CO2 reduction required become more difficult to achieve.

• The deep long-term emission cuts also imply a greater reliance on specific technologies and reduced societal choices. In particular, in case of weak short-term policies the 2°C limit can only be kept with large-scale deployment of bioenergy and CCS.

• A further delay of mitigation action results in greater overall costs of the mitigation effort, and a more unequal distribution of these costs over time. In particular, further delay that a further delay increases the economic costs during the transition from a weak to a comprehensive climate policy regime, thus raising the barrier to the low-carbon transformation.

• Finally, replacing fossil fuels by climate-friendly alternatives of greater social benefits, such as decreased air pollution and improved energy security. Delaying climate policy implies that crucial co-benefits, such as decreased air pollution and improved energy security, are foregone.

The presentation will further explore how enhanced near-term action and post-2020 policies can reduce these adverse effects, thus helping to keep the 2°C target within reach.

O-4402a-01

The energy transformation in 2°C pathways: upscaling technology, investment needs, stranded assets and the role of energy demand

V. Krey (1) ; C. Bertram (2) ; J. Eom (3) ; N. Johnson (1) ; D. Mccollum (1)

(1) International Institute for Applied Systems Analysis (IIASA), Energy program, Laxenburg, Austria; (2) Potsdam Institute for Climate Impact Research, Potsdam, Germany; (3) KAIST Business School, Graduate school of green growth, Seoul, Republic of Korea

A major challenge in limiting temperature change to 2°C compared to pre-industrial levels is the transformation of the energy system which requires rapid upscaling of low-carbon technologies to significantly reduce GHG emissions. Deploying the energy technologies needed to initiate a sustained energy system transformation requires continued research and development as well as significant investments to be mobilized by the global economy.

The timing of mitigation action and in particular the stringency of near-term climate policy determines the challenge we are facing now versus the challenge we may face in a couple of decades. While delaying stringent climate action has the benefit of allowing for more development space over the coming decade or two, it amplifies the need to rapidly decarbonize the energy system thereby if temperature change should be contained to 2°C or less. An important implication of weak near-term climate policies is the need to prematurely retire carbon-intensive infrastructure such as coal power plants and oil wells, once moving to a more stringent climate regime. This trade-off particularly affects developing nations that are still in the process of building up a large part of their infrastructure.

In this contribution we will present results on technology upscaling, investment and decarbonization rates from integrated, model-based scenario studies. These will be put into the context of historical developments, both at the level of countries and regions and at the level of individual technologies.

In addition, the decarbonization of the energy supply sector needs to be complemented by a switch to low-carbon energy carriers in the end-use sectors as well as the reduction of energy demand, both of which are key strategies to reduce GHG emissions. In particular the latter is shown to provide additional flexibility for an energy system transformation, by hedging against potential resistance to a large-scale deployment of energy-supply technologies and by reducing stranded assets as well as generating multiple non-climate benefits.

O-4402a-02

Global Energy and Climate Outlook: Road to Paris – Economic Assessment of Low Emission Levels under World Action Integrating National Contributions

Z. Vrontisi (1) ; B. Saveyn, (1) ; T. Vandyck, (1) ; A. Kitous, (1) ; A. Labat, (2) ; M. Perry (2)

(1) European Commission (DG JRC–IPTS), Institute for prospective technological studies, Seville, Spain; (2) European Commission (DG Climate Action), Brussels, Belgium

On 25 February 2015, the European Commission has set out its Communication, «The Paris Protocol – a blueprint for tackling global climate change beyond 2020» in the EU’s Energy Union package. This paper presents the work undertaken in the context of the abovementioned EC Communication regarding the economic impacts of post-2020 global climate change mitigation policies. The analysis presented here mainly lies on results from the economic model GEM–E3, combining the work undertaken with the energy systems model POLES for the purposes.
4402b - Low carbon pathways for staying below 2°C: Global requirements

**ORAL PRESENTATIONS**

**K-4402b-01**

Regional greenhouse gas emission pathways within the context of the 2°C target: Insights from the LIMITS project

D. Van Vuuren (1); M. Tavoni (2)

(1) PBL Netherlands Environment Agency, PBL, Climate, air pollution and energy, Bilthoven, Netherlands; (2) Fondazione Eni Enrico Mattei, Climate change and sustainable development programme, Milan, Italy

Integrated assessment models can help in quantifying the implications of international climate agreements and regional climate action. In several recent model comparison studies, different possible outcomes of post-2020 climate negotiations were explored in relation to the 2°C target. The scenarios developed in these projects can be used to derive key information for individual (major) economies and regions. This includes for instance information on emission peaking, regional carbon budgets and emission allowances. In this contribution, we present these outcomes (especially those of the LIMITS project) and focus on the differences across these regions. For instance, in terms of mitigation measures, costs and carbon budgets clearly different results can be noted. In our contribution, we also highlight the distributional consequences of climate policies, and discuss the role of carbon markets for financing clean energy investments, and achieving efficiency and equity.

As the models presented in this contribution do have global coverage – the presentation allows also to act as a broad brush over the two important parts of a contribution on low carbon emission pathways (global and regional).

**K-4402b-02**

National pathways to deep decarbonization - Methodological insights from the Deep Decarbonization Pathways Project (DDPP)

H. Waisman (1); M. Colombier (1); E. Guérin (2); J. Sachs (2)

(1) Institute for Sustainable Development and International Relations, Paris, France; (2) Sustainable development solutions network, New York, United States of America

Can countries take the carbon out of their economies, and still provide economic prosperity for their citizens? National circumstances and approaches differ, but four pillars of decarbonization are identified universally, in developed and developing countries alike: (i) strong improvements in energy efficiency, (ii) making energy carriers almost zero carbon (low-carbon electricity sources, biofuels, hydrogen), (iii) shifting energy use as far as possible to the low-carbon energy carriers which are available and the most cost-effective, (iv) recycling emissions revenues to reduce taxes on labour. Economic costs can be reduced further if the auction revenues are not used only for tax reductions but are combined with a financial scheme.

The approach of DDPP is to have country research teams develop a national-scale pathway analysis for deep decarbonization consistent with the 2°C global target to 2050. This study is supported by expert-based assessments of national decarbonization pathways through process established in the run-up to Paris COP21 by studying a combination of domestically determined mitigation targets for the period beyond 2020.

The GEM–E3 model is a recursive dynamic computable general equilibrium model which covers the interactions between the economy, the energy system and the environment. The model is calibrated to the 2004 base year of the GTAP 8 database. This version of the model represents 21 sectors, 10 power technologies and 25 regions, including all major economies. The six Kyoto greenhouse gases represented are CO2, SF6, PFC, HFC, CH4, and N2O. The POLES model is a global sectoral simulation model for the development of energy markets.

The GEM–E3 and POLES models share a harmonised Baseline with population and economic growth projections based on the UN and OECD. The projections do not consider the impacts from unabated climate change. In this 2°C baseline scenario, global emissions would increase at unsustainable levels: from 48 GtCO2e in 2010, 61 GtCO2e in 2030 to 68 GtCO2e in 2050. Along such trajectories, the world is at risk to experience a global temperature increase of +4°C, with sizeable impacts on sustainable growth and vulnerable groups in all regions. The Global Mitigation scenario is in line with staying below 2°C, with global GHG emissions peaking in 2020 and reaching about 43 GtCO2e in 2030, still higher than in 1990 (+20%) but lower than in 2010 (~10%).

The economy-wide impacts are twofold. Firstly there are direct costs of mitigation due to regional emission constraints and the reallocation of resources for the mitigation effort. Secondly there are indirect costs or benefits from changes in competitiveness, production patterns, investment and relative prices of energy, labour and capital. It is seen that carbon-intensive sectors need to adjust their investments in order to reduce their emissions, and sectors with a low emission-intensity are affected according to their level of openness to emitting sectors. The effects analysed include GDP, sectoral activity, exports and imports, employment, private consumption and investment. The results indicate that, although due to reallocation of resources created by a global mitigation effort, negative impacts on GDP are seen for all regions, in effect, climate change mitigation policies only marginally reduce the yearly economic growth rates in fast-growing low-income regions. A decomposition analysis of the drivers of GDP change gives a further insight on the impacts of the global mitigation policies.

Another dimension of the analysis is the choice of policy instruments. For this purpose, we compare the use of free allocation of permits, auctioning and carbon taxes. The revenues of auctioning or taxation are recycled as a lump-sum to households, a reduction in labour taxes or in indirect taxation on consumption and investment. It is found that, depending on their regional economic characteristics, for the majority of the regions the optimum recycling of permit auction revenues is to lower indirect taxes or increase returns for carbon-intensive activities, while emissions revenues to reduce taxes on labour. Economic costs can be reduced further if the auction revenues are not used only for tax reductions but are combined with a financial scheme.
to the backcasting long-term approach, the «dashboard» methodology that allows transparent and explicit representation of the pathways and the iterative process for elaboration of the national pathways.

K-4402b-03

Technology Policies and Accelerated Diffusion of Decarbonization Wedges

P. Criqui (1); N. Alazard-Toux (2); JG. Devezzeaux De Lavergne (3)

(1) CNRS and ANCRE, Pacée–edden, 38040 Grenoble cedex, France; (2) IFPEN and ANCRE, Direction économie véllée, 1–4 Avenue du Bois–Préau, 92852 Rueil Malmaison Cedex, France; (3) CEPI and ANCRE, 1-téé, centre de scayl bâamiento 524, 91191 Gif Sur Yvette, France

The rapid and deep decarbonization of energy systems that is required to hold the 2°C scenarios will result from a complex mix of institutional, behavioral and technological changes. While many economic models and mitigation scenarios have initially focused on the role of economic instruments for triggering these changes, the role of new technologies have been progressively been made more explicit as a central element for the feasibility of low carbon futures. In particular, filling the gap between bottom-up nationally determined contributions and the requirements of 2°C scenarios will require a worldwide effort to accelerate the diffusion of energy efficiency and low carbon options.

Following to pioneering studies (Stabilization wedges, Socolow and Pacala [2004], Energy Technology Perspectives, IEA, since 2006) the role of new energy technologies has been extensively studied in the past ten years (EMF, Emission projections, European framework programs, AR5...). While a new stage in climate negotiations and policies is expected to start when the Paris Climate 2015 results in a positive outcome, the fulfillment of the announced Nationally Determined Contributions will involve a quick mobilization and scaling-up at world level of low carbon technologies, on the demand as well as on the supply side.

Research projects such as the Deep Decarbonization Pathways Project of UN–SDSN provide clear images of what has to be accomplished in the different countries in order to come closer to emission trajectories compatible with the 2°C scenarios. However further enquiry is needed to explore both the radical/systemic innovations and the policy and social dimensions of the accelerated diffusion of low carbon technologies. In this context, the National Alliance for the Coordination of Energy Research (ANCRE), which gathers the scientific resources of the main public research institutions in France, proposes a communication on the development of low carbon energy technologies and systems. These are the “Decarbonization Wedges” that ANCRE is currently exploring in an eponym study that mobilizes the knowledge resources of this organization.

The communication will first identify the main decarbonization wedges to 2050 and analyze their potential, Technology Readiness Level, and expected development in different regions according to international studies such as Deep Decarbonization Pathways. It will then analyze the different types of barriers to be overcome before the rapid and massive diffusion: either technical, economic or social. It will then present elements of consistent RD&D strategies at the international and national level to speed-up the diffusion of these technologies in the different regions of the world.

Analysis of current climate policies, intended national determined contributions (INDCs) and possibilities for strengthened policies at the regional scale

M. Den Elzen (1); H. Fekete, (2); A. Amirial, (1); N. Forsell, (3); N. Höhne (2); A. Korosuo, (3); M. Roelfsema, (1); H. Van Soest (4); K. Wouters, (5); T. Day, (2); M. Hagemann, (2); A. Hentschell, (3)

(1) PBL Netherlands Environmental Assessment Agency, Department of Climate, Air and Energy, Bilthoven, Netherlands; (2) NewClimate Institute, Cologne, Germany; (3) IIASA, Laxenberg, Austria; (4) PBL Netherlands Environmental Assessment Agency, Climate, Air and Energy, Bilthoven, Netherlands; (5) Ecofys, Utrecht, Netherlands

This study provides an overview of projected greenhouse gas emissions in major countries/regions up to 2030, taking into account the emission trajectories based on the most effective current and planned climate and energy policies, as well as selected enhanced mitigation measures and national priorities and opportunities (e.g. co-benefits). The analysis focuses on 13 countries/regions (Australia, Brazil, Canada, China, European Union, India, Indonesia, Japan, Mexico, Russia, South Korea and the US). The impact of the most effective current and planned policies on greenhouse gas emissions was estimated based on calculations from energy and land use model calculations, and scenarios from international studies. The main findings are:

- The degree to which countries/regions are likely to achieve their 2020 pledges under current policies varies: of those considered here, Brazil, China, the EU, India, Japan and Russia are likely to achieve their pledges through existing policies. Australia, Canada, Indonesia, Mexico, South Korea and the US require additional measures to achieve their 2020 pledges. The US and Mexico could achieve their pledges if planned policies are effectively implemented.
- Even though current and planned policies are projected to have an effect on emissions, increases would still occur in Australia, Canada, China, India, Indonesia, Mexico and Turkey until 2030. Emissions in Brazil, Canada, South Korea, the Russian Federation and the US would remain stable approximately at 2010 levels. For the EU, emissions are projected to decrease further under current policies, but not enough to meet the INDC of EU of a 40% domestic reduction target by 2030.
- In all the countries/regions considered, significant further reductions are possible through a selection of policy enhancement measures that are in line with national priorities. The selection of policies and measures is illustrated in a study that we group in terms of whether they assess “moral obligation” or “technical necessity”.

Applying these methods to existing proposals by the USA, China and the EU, a consistent picture emerges that the proposals by EU and China are more ambitious than the proposal by the USA. The methods do not provide a consistent picture on what China’s proposal is more ambitious. While China leads slightly on “moral obligation”, the EU generally leads on “technical necessity.”

4402 – POSTER PRESENTATIONS

P-4402-01

A 90% Reduction in Canada's Emissions by 2050: Macroeconomic and physical evoluation or revolution?

C. Bataille (1)

(1) Institute for Sustainable Development and International
What does 90% decarbonization of the Canadian economy look like, physically and financially? Is it a financial evolution, or a revolution? An opportunity or a calamity, an eventual win or a death spiral? What are the uncertainties? Canada already has strong and binding long term policies on transport and buildings whereas, with a couple of exceptions, regulations are largely missing for industry. In this analysis we have explored three different sets of regulations and add policy for industry. I use a regionally and sectorally disaggregated CGE methodology to model the following policy package. 1) Advanced efficiency regulations for transport, buildings and appliances, on the premise there are significant plausible market failures & pricing policies may be ineffective. 2) Regulations requiring oil and gas fugitive control and CCS on gas processing and hydrogen production, with the right to sell verifiable reductions into the following “market”. 3) A tradable emissions intensity standard for all large emitter based on sector-specific “factor 4–in-class” technology intensities within target. 4) A complete transition package with an initially low but continually rising British Columbia style carbon tax with 50/50 recycling to labour and corporate labour taxes that eventually eclipses the other policies.

For results I will review GDP, emissions, changes in sectoral investment and economic structure. I will conclude with a methodological discussion of the modelling changes that were needed to hit 2 tonnes per capita, including additional decarbonization technologies and changes to the modelling structure.

**P-4402-02**

Complementing carbon prices with technology policies to keep climate targets within reach

C. Bertram (1); G. Luderer (1); R. Pitzcker, (1); E. Schmid, (1); E. Kriegler (1); G. Edelhofer (1)

(1) Potsdam Institute for Climate Impact Research, Potsdam, Germany

Economic theory suggests that comprehensive carbon policies with efficient and ambitious climate targets, and previous studies indicated that the carbon price required for limiting global mean warming to 2 °C is between US$16 and US$73 per tonne of CO2 in 2015. Yet, a global implementation of such high carbon prices is unlikely to be politically feasible in the short term. Instead, most climate policies enacted so far are technology policies or fragmented and moderate carbon pricing schemes. This paper shows that ambitious climate targets can be kept within reach until 2030 despite a sub-optimal policy mix. With a state-of-the-art energy-economy model we quantify the interactions and unique effects of three major policy components: (1) a carbon price starting at US$7 per tonne of CO2 in 2015 to incentivize economy-wide mitigation, flanked by (2) support for low-carbon energy technologies to pave the way for future decarbonization, and (3) a moratorium on new coal-fired power plants to limit stranded assets. We find that such a mix limits the efficiency losses compared with the optimal policy, and at the same time lowers distributional impacts. Therefore, we argue that this instrument mix might be a politically more feasible alternative to the optimal policy based on a comprehensive carbon price alone.

To limit the mitigation costs and risks of achieving the 2 °C target, it is essential to start comprehensive climate policy as early as possible. Recent studies have shown that policies such as a carbon price can significantly reduce emissions pathways reaching the 2 °C target. Furthermore, a continuation of climate policy at the current ambition level will not lead to a stabilization of climate change, although the current trajectory alone will significantly exacerbate the challenge of reaching long-term climate policy objectives. Current policies fail to induce the transformation of the energy system to the extent required by current climate targets, but lead to further lock-in into carbon-intensive infrastructure. Not only do too much emissions occur in the near term, but also mitigation later on is rendered more difficult. It is important to develop new technological policies to reduce such lock-in and mitigate the impacts of delay. Although a few studies based on global energy-economy models have considered single packages of technology policies in their analysis of twenty-first-century mitigation pathways, none of them explored this question.

The environmental economics literature has also not focused on the scope of technology policies for overcoming deficiencies in carbon pricing. In this strand of scholarly work, technology policies have mainly been analysed as means to cure market failures beyond the pure pollution externality, for example, due to learning spillovers, information asymmetries and so on. In contrast, here we analyse their complementary role under sub-optimal carbon pricing. There is wide agreement that market-based instruments like transport and buildings are more feasible alternative to the optimal policy based on a comprehensive carbon pricing combined with technology policies.

This study is the first to assess which mix of emission pricing and technology policies is effective in avoiding further lock-in and initiating the transformation required for limiting warming to 2 °C. We thus fill an important gap in the literature by informing the ongoing climate policy debate, which so far revolves around modest approaches to carbon pricing and various forms of technology policies in several countries around the world, tantamount to a lack of comprehensive emissions pricing in line with the 2 °C limit.

Our analysis identifies a policy mix that—based on the positive effects of technology policies under sub-optimal carbon pricing—keeps ambitious climate targets within reach. We find that successful climate policies can be achieved by a mix of carbon pricing and technology policies, including industry regulations, in combination with technology policies.

**P-4402-03**

Energy transitions in France: lessons from a forward-looking study

R. Bibas (1); JC. Hourcade (1)

(1) International Research Center on Environment and Development (CIRED), Paris, France

The general equilibrium model Imacil France-R is used to examine various energy transition strategies leading to a path Factor 4. The macroeconomic balance a set of assumptions about the technical conditions of supply and demand for energy varies as it is not housed in a package that does not come from one area of energy policy: fiscal policies to prevent the spread of the additional costs of energy in industry; environmental policies to wage bargaining to manage the recycling of the product of a carbon tax, reform of financing structures, industrial policies, and training for new jobs, infrastructure policies, reducing fears that explain the reluctance of market participants and trigger a shift in investment towards faster simple equipment into energy. The macroeconomic balance changes according to the terms of the transition, but is positive in the medium and long term in terms of growth and employment, this because of the synergy between three mechanisms: decrease of energy imports, energy savings releasing purchasing power of households in non-energy goods and services, lower labor costs allowed by a carbon tax.

Economic Support of the Transition is critical to move from a slightly negative balance in the short term to a positive balance sheet, in order to give the ‘grist’ needed to reduce these emissions challenges. The challenge is to find the ‘right’ balance between stock and behavioral change. We then show how a funding policy lowering the coefficient of investment risk ‘low carbon’ would, by enhancing the credibility of public policies, reduce fears that explain the reluctance of market participants and trigger a shift in investment towards faster simple equipment into energy. The macroeconomic balance changes according to the terms of the transition, but is positive in the medium and long term in terms of growth and employment. This is because of the synergy between three mechanisms: decrease of energy imports, energy savings releasing purchasing power of households in non-energy goods and services, lower labor costs allowed by a carbon tax.
Technology and innovation to low-carbon pathways in Brazil

B. Bressan (1) ; M. Poppe, (2) ; G. Jannuzzi, (3) ; A. Furtado, (3)
(1) Centre for Strategic Studies and Management in Science, Technology and Innovation (CGEE), Sustainable Development Centre, DF, Brazil; (2) Centre for Strategic Studies and Management in Science, Technology and Innovation (CGEE), Sustainable development, Brasilia – DF, Brazil; (3) University of Campinas - UNICAMP, Mechanical engineering faculty, Campinas – SP, Brazil

The UNFCCC intends to approve more stringent targets to reduce carbon emissions globally. One of the instruments that has been created by the Climate Convention is the Technology Mechanism. This mechanism comprises a Technology Executive Committee (TEC) and a Climate Technology Centre and Network (CTCN).

Developing countries are asked to prepare reports detailing their technological needs to develop mitigation and adaptation climate plans. These reports are known as Technology Needs Assessment (TNA) and are prepared according to suggested guidelines and offer the basis for technological procurement and transfer efforts of select technologies which are already commercially available.

CGEE (a non-profit organization with the mission of rendering Science, Technology and Innovation as Brazil’s best allies for economic growth, competitiveness and well-being) is coordinating, as a subsidy for the Ministry of Science, Technology and Innovation, a group of experts with wide experience on technological development and transfer in order to propose a suitable methodology for the Brazilian reports, oriented to formulate a Technology Capacities and Needs Assessment (TCNA). Therefore, technology needs are associated to national capacities and competencies supporting the designing of a Technology Action Plan (TAP) to fight climate change. Moreover, a technology pool indicates the possibility for developing countries to not only attract know-how and new technologies, but also to be able to offer these resources to other countries.

The contribution aims to improve the assessment and action plans taking into account the opportunity for developing countries to enhance and promote its science and technology base and to create new solutions to more meaningful low-carbon pathways in their own social context. One key step in the proposed methodology is a detailed inventory of local capacities and competencies not only within the science and technological communities but also in the industrial base. So, it will be possible to enhance the national innovation chain and place developing countries as more relevant international players in the arena of technological development and transfer.

In this study we present a feasibility study performed with the latest version of the TIAM-UCL model on the possibility to achieve different targets on the global temperature change due to greenhouse gas emission reduction. The study specifically analyses what will take us to meet the 2°C target in terms of peaking years and subsequent reduction rates needed. We also analyse two less constrained targets at 2.5°C and 3°C.

The first part of the study focus on the relationship between the peaking of emissions (before mitigation policy) and the minimum percentage change in the emissions reduction after allowing the target to be achieved. Increasing temperature target (2.5 and 3°C) or the maximum rate of emissions reduction reduces the need of early mitigation policies (before 2025). In the case of the 2°C target, allowing overshooting of the target before stabilisation has the same effect. Given the continuing delay in implementing a global agreement on greenhouse gas emission reduction, we initially examined the window of opportunity to continue increasing emissions whilst still limiting the average surface temperature rise. We found that while it may still be possible to limit the average global temperature rise to the nominal 2°C target agreed on by policy makers, the opportunity window for realising this is closing rapidly.

We study in a second part more specifically the pathways toward the stringent 2°C target. The focus is now on where the mitigation occurs between developed, emerging and developing economies and what technologies and resources are needed. Per capita emissions were found to fall in all regions globally: in high-income regions these drop to less than a quarter of their 2010 level by 2050, while in middle and low-income regions they fall by 50%. On the technology side, we present the deployment rates of the low-carbon technologies needed to achieve the targets. The first sector to decarbonise will be electric. Over the next fifty years the electricity sector could be responsible for up to 40% of the global greenhouse gas emission reduction.

The objective of the study was to assess the feasibility of the Technology Action Plan (TAP) to fight climate change in the developing countries.

In conclusion, the opportunity to prevent a temperature rise less than 2°C remains possible and is indeed entirely necessary. However perhaps this opportunity becomes increasingly unlikely due to the required scale of the investments required.
mix). The study explores the techno-economical pathways of sectoral and regional developments to 2030, taking into account realization of the potential for energy efficiency improvement and renewable energy deployment.

Beyond the reference scenario (which includes no additional policy measures or technology development beyond the current status quo assumptions), we create three alternative scenarios. The first alternative scenario focuses on meeting the SE4ALL 2030 energy efficiency target through a combination of more ambitious technological improvements and policy incentives within end use energy consumption in the buildings, industry and transportation sectors. To create this scenario, we simulate substantial improvements in conventional technologies’ efficiencies, phasing out of energy intensive technologies at an accelerated pace (replaced with more advanced technology) and the consideration of innovative new technologies not yet widely available in the market.

The second alternative scenario focuses on achieving the SE4ALL 2030 renewable energy targets. This scenario sets both global and region-specific targets to closely follow those outlined by the International Renewable Energy Agency Global Renewable Roadmap (IRENA REMap2030).

The third alternative scenario combines the first two.

The alternative scenarios also incorporate the effect of various barriers to energy efficiency development, to simulate various known social, political, and economic effects that curtail adoption of new technologies. This allows for a more effective representation of meeting the SE4ALL targets.

The technology-rich TIMES Integrated Assessment Model (TIAM) is employed to analyze the various scenarios. From here, we develop technology and policy pathways for different regions for meeting the SE4ALL energy efficiency and renewable energy goals. The pathways are evaluated in terms of cost effectiveness and by assessing the degree to which modern technology is dispersed across the various regional technology profiles (the first objective of SE4ALL). The pathways are formulated as recommendations and cost estimates for best achieving the SE4ALL objectives.

P-4402-08
Towards a low-carbon Chinese economy: the role of transportation
M. Hamdli-Cherif (1)
(1) CIRED, Nogent-Sur-Marne, France

Rationale and Objective: Chinese economic development goes hand in hand with (i) a growth of the production that is accompanied by an increase of the freight transport, and (ii) an enriched population and fast-growing urbanization that induce increasing demand for passenger transport (notably an increase of the motorization rate). Given the high reliance of transport on oil products, its increasing energy demand and CO2 emissions, the transportation sector is a crucial sector for China, particularly regarding energy security and climate change issues. In its attempts to have a sustainable development, the transportation sector is indeed particularly challenging for China. To avoid important “lock-ins” in carbon-intensive pathways, especially given the high coal availability and the high dependency of infrastructures, China has to redouble its efforts with voluntary schemes promoting mobility growth control. This paper investigates the role of transportation activities in the transition to a low carbon Chinese economy and the possible role of policy measures designed to control the growth of mobility. It is an attempt to quantify the impact of urban voluntary policies on Chinese mitigation costs.

Methodology: This article revisits the role of the transportation sector in low-carbon pathways by using the Integrated Energy System Model IMACLIM-R. It is a hybrid multi-region, multi-sector CEGE model, which embeds a detailed description of passenger and freight transportation. The standard representation of transport technologies is supplemented by an explicit representation of the “behavioral” determinants of mobility. The model relies on hybrid matrices ensuring consistency between money flows and physical quantities and allows an explicit representation of the interplay between transportation, energy and growth patterns. It accounts for the rebound effect of energy efficiency improvements on mobility, endogenous mode choices in relation with infrastructure availability, the impact of investments in infrastructure capacity on the amount of travel, and the constraints imposed on mobility needs by firms’ and households’ location. Moreover, IMACLIM-R represents the second best nature of economic interactions and the inertias on technical systems that limit the flexibility of adjustments, a crucial dimension for emerging economies when envisaging large structural change over the course of the century.

**Complementarily to carbon pricing to reach a stringent climate objective (3.4W/m2 in 2100), we consider actions to control the “behavioral” determinants of transportation in the course of the low-carbon transition, and assess their effects on the Chinese economy. More specifically, we consider (i) urban reorganization lowering the constrained mobility (i.e. mobility for commuting and shopping), (ii) reorganization of the freight transportation induced by the promotion of innovative new technologies not yet widely available in the market.

Results: This analysis demonstrates the risk of high losses if using carbon price as the sole instrument of mitigation. Transport proves to be the sector for which carbon emissions are the more difficult to reduce. It thus represents a dominant share of remaining emissions in the long-term with ambitious mitigation objectives are set. Because of its weak reactivity to price increases, very high levels of carbon prices are needed in the second half of the century to reach low mitigation targets. We find indeed that they can be achieved only if non-transport strategies are implemented. But we find that controlling mobility growth allows limiting these effects by offering mitigation potentials independent of carbon prices. The considered measures allow significant reductions in CO2 emissions prices (average 25% lower over 2050–2100) and hence help limiting the macroeconomic costs of the mitigation policies (e.g. long-term mitigation costs are reduced by 5 points in 2050 and by 10 points in 2100).

Conclusion: This study highlights the role of transport in the mitigation process. Given a climate target, the implementation of additional policy measures or technology development beyond the current status quo assumptions), we create three alternative scenarios. The first alternative scenario focuses on meeting the SE4ALL 2030 renewable energy targets. This scenario sets both global and region-specific targets to closely follow those outlined by the International Renewable Energy Agency Global Renewable Roadmap (IRENA REMap2030).

P-4402-09
A pathway to a low-carbon society for China
Z. Mi (1)
(1) Beijing Institute of Technology, School of Management and Economics, Beijing, China

As the leading primary energy consumer and the largest carbon-emitting country in the world, China is facing great international pressure to reduce its carbon dioxide (CO2) emission, as well as a tight domestic fossil energy supply and a high level of air pollution. In the “U.S.–China Joint Announcement on Climate Change” released on November 12 2014, China announced to achieve the peaking of CO2 emission around 2030 and to make best efforts to peak early. Therefore, this study aims to answer whether and how China’s CO2 emission can peak before 2030. A dynamic multi-objective optimization model will be developed based on the multi-region input-output model to explore an appropriate low-carbon pathway for China’s sustainable development, comprehensively considering factors like industrial structure, energy structure, energy efficiency, consumer behaviors, and environmental capacity. Under this pathway, China is expected to assume its responsibilities to mitigate global climate change, reduce domestic pollution, and sustain a rational economic growth.

P-4402-10
Pathways to be Opened towards Low Carbon Society – Findings on Multi-model Comparison in ICA-RUS Project
S. Mori (1) ; T. Washida (2) ; A. Kurosawa (3) ; T. Masui (4)
(1) Tokyo University of Science, Department of Industrial...
Although the world agrees with the need for the greenhouse gas control in the long views, there are still serious barriers to be resolved towards the near term policy decisions. The scientific and the societal uncertainties in the climate change policies must be the large part of this barrier. Besides the unknown factors in the natural science fields, various international, macro and micro economic outcomes of mitigation policies, the technology strategies, possibility of adaptation options, and the risk and benefits of the geo-engineering will cause complex interactions and determining the future generation as well as among regions will also be the problem. The most preferable and acceptable decision making towards the agreement should be established from the challenges. Comprehensive analysis is indispensable as a basis of discussion.

The Ministry of the Environment, Japan established an interdisciplinary research project, Integrated Climate Assessment – Risks, Uncertainties and Society (ICA-RUS) conducted by Dr. Seita Emori, National Institute for Environmental Studies. In order to deal with the various uncertainties, four different type integrated assessment models, i.e. MARIA–14(Mori), EMEDA(Washida), GRAPE(Kurosawa) and AIMM(Masui) participating in this project to provide different views and the common information with respect to societal impacts of global warming strategies. For instance, the iterative optimization CCG, now have a capability to provide gaming simulations among states. MARIA and GRAPE provide detailed technology strategies as well as the land use changes through the inter-temperal optimization. AIM which consists of multiple model modules provides most comprehensive information. In the ICA-RUS project, these models generate various solutions under same SSP and RCP based scenarios, providing common information on economic low-carbon regional GPP, and models of the above give energy technology option and land use changes while EMEDA provides sectoral impacts. We also employ three “Alternatives left to humanity” represented by mitigation targets, 1.5, 2.0 and 2.5 degrees C global mean temperature increase (with assuming the climate sensitivity of 3.0 degreesC).

The current tentative conclusions are summarized as follows: first, in the stringent climate target, the regional economic losses among models tend to diverge. This variety seems to depend on the assumption on the malleability of the final energy demand, especially of the transportation sector. Second, CCS as well as BECCS will be essential to achieve the stringent climate target. Third, industry structure changes in Asia and Africa will affect the world level uncertainties in the transportation sector. Fourth, the models show small changes in the crop production and land-use patterns among various climate scenarios suggesting that the implementation of BECCS and the biomass energy expansion may not seriously conflict with the food supply under the reference conditions.

Finally, some additional simulations on multi-stage decision making to deal with adaptive energy technology strategies will also be shown.

P-4402-11

Linking leadership to the upcoming global climate regime: Insights from the German Energiewende

M. Pahle (1); K. Steinbacher (2)

(1) Potsdam Institute for Climate Impact Reserach (PIK), Potsdam, Germany; (2) FU Berlin, Environmental policy research centre (fku), Berlin, Germany

In a nutshell, the main current problem with action for climate protection is that too many countries are doing too little. The run-up to COP 21 in Paris will without doubt see the formulation of numerous recipes on how to cope with this challenge. But leadership exerted by frontrunning countries has the potential to stand out in the end as one of the most effective ways of pushing climate action. The particular clout of leadership is that ambitious countries can take immediate action “out of their own accord without being thwarted by inconclusive international negotiations. The hope behind this is to attract followers for a similar course of action and thus sidestep global stalemate. It is true that unilateral leadership, i.e. acting when no one else does, with a hope to set an example - entails the risk of being in vain if it lacks followers, resulting in considerable costs for the leader. Nevertheless, in a world of increasingly polycentric governance, the particular clout of leadership at the national level is indispensable – and leadership puts this national action at the service of a common cause. But what does it precisely mean for countries to be a leader and how can leadership be put into practice outside institutionalized multilateral negotiations, in a polycentric regime? Answering these questions is essential to increase the leverage of national action in supporting climate action at the global level. A better understanding of leadership in a polycentric climate regime is thus what we aim for in this paper.

The particular case we look at is the German energy transition, now widely known as the “Energiewende.” Formally enacted in 2011, but based on a much longer history of transition, the Energiewende has sparked considerable interest around the globe. Beyond its perception as a potential source of – positive and negative – lessons, choosing the Energiewende as a case is particularly relevant due to the fact that it is the only path to a more sustainable energy system has been a main rationale and German decision-makers frequently claim leadership in this field. Our investigation concentrates on “leadership by diffusion” outside multilateral negotiation settings, and uses a simple analytical framework derived from the literature on leadership and policy diffusion. In a first step, we analyze the specific motivations for international Energiewende leadership and the ways in which they have taken to translate this aim into action. We subsequently discuss Germany’s approach to Energiewende leadership against the background of an evolution of the Energiewende itself. From this analysis, we find that while Germany has been a highly active leader facilitating the worldwide diffusion of renewables, a comprehensive leadership strategy in line with the very high ambitions of the Energiewende – towards a comprehensive energy system transformation has not yet emerged.

Based on this finding, we discuss the requirements for such an approach, including efficiency across government, transparent communication and open dialogue with potential followers. Given that the main declared motivation for Energiewende leadership is to advance global climate action, this strategy above all needs to be geared towards effective climate leadership. Crucial for this is (a) to safeguard legitimacy of the Energiewende as a policy model by giving priority to climate protection at the domestic level, and (b) to align national policy with knowledge created in the implementation process is shared and adaptable to the local context in other parts of the world ("receiving side"). We eventually lay out how these activities can be further intensified in the upcoming international regime, and how in turn the requirements of effective climate leadership can be taken into account in the future course and implementation of the Energiewende.

P-4402-12

Interactions between agriculture mitigation choices and fossil CO2 emissions within integrated low-carbon pathways to limit warming to 2 degrees

A. Reisinger (1); A. Daigneault (2); J. Rogelj (3)

(1) New Zealand Agricultural GHG Research Centre, Palmerston North, New Zealand; (2) Landcare Research, Governance and policy, Auckland, New Zealand; (3) IIASA, Laxenburg, Austria

Agriculture currently directly contributes 10–12% of global greenhouse emissions, with additional emissions from land-use changes to carbon emissions in food production, processing and transport. Emissions from agriculture are projected to continue to increase for much of the 21st century as a result of a growing and more affluent population that demands more high-quality and protein-rich food. In total, agriculture is thus responsible for more emissions than global air, land and sea transport, and (depending on the method of allocating indirect emissions) almost as much as stationary energy supply.
This suggests that mitigation of agricultural emissions might be the part of integrated abatement strategies, especially for stringent goals such as limiting global average warming to below 2 degrees relative to pre-industrial levels. However, while the challenge of decarbonizing key sectors responsible for emissions of carbon dioxide from fossil fuels is increasingly well understood, there is much less visible action at a global scale to tackle emissions from agriculture, due in part to perceived tensions between food security and climate. The eradication of hunger and poverty is a handiest way to mitigate agricultural greenhouse gas emissions on the other. In addition, while there is significant potential to reduce emissions per unit of product for most agricultural systems, there is little prospect for completely "decarbonizing" food production at the global scale, in contrast to e.g. the electricity and potentially even transport sectors. The limited abatement potential and intersection of food security and poverty with mitigation policies this tendency to mitigate agriculture, could be the "too-hard" basket for climate policy priorities, and a perception that the global climate benefits from enhanced agriculture mitigation would not be commensurate with the effort and trade-offs required.

Here, we use global integrated assessment models to demonstrate that even though technical mitigation options for agriculture are more limited than for some other sectors, accelerating agriculture mitigation outcomes can make a crucial contribution to keeping the goal of limiting warming to below 2 degrees viable. We show that different assumptions specifically for agriculture mitigation potentials and policy approaches strongly influence global shadow prices for GHGs throughout the 21st century, optimal climate costs and timing of peak of carbon dioxide emissions from fossil fuels in global cost-effective multi-gas abatement strategies, and also influence the rate of decarbonization required from intensive sectors after emissions have peaked. We further explore how different approaches to agriculture mitigation (encompassing closing yield gaps, reducing demand, and increasing technical abatement options) could influence global commodity prices and land demand, and thus what measures could enable achieving goals of food security, poverty eradication and limiting climate change jointly.

We conclude that expanding the overall mitigation potential for agriculture-related emissions and supporting practices to realize this mitigation potential in practice are critical components of integrated efforts to achieve low-carbon pathways, and that therefore the role of agriculture in climate policies and integrated approaches to mitigation warrants much higher attention than has been evident in climate policy design to date. Perhaps ironically, we note that in a globally cost-effective approach to mitigation, the greatest near-term benefits from enhanced agriculture mitigation would accrue to the most CO2-intensive sectors and regions. The integration of countries' internal political constraints modifies this tendency to mitigate agriculture, could make more plausible the design of a global agreement. For that reason, this approach is relevant for the theme of day 4 “Collective action and transformative solutions".

Low carbon pathways prioritising human needs and development

J. Steinberger (1) ; W. Lamb (2)
(1) University of Leeds, School of Earth & Environment, Leeds, United Kingdom; (2) Tyndall Centre for Climate Change Research, School of Mechanical and Civil Engineering, University of Manchester, Manchester, United Kingdom

Human societies have always required environmental resources, in the form of energy and materials, to survive and flourish. However, the exact level of resource requirements may be difficult to estimate, since it can depend on many factors. These factors include: local biophysical conditions, such as climate or available crops for food; technological options and efficiencies for energy use; the key social, economic, or political parameters, including consumption levels and inequality in distribution. This talk will present recent advances in the international study of energy requirements for human needs. These results demonstrate that high levels of human wellbeing are attainable at moderate as well as very high energy use, and that the average level of energy use required to achieve high human wellbeing is declining over time. Moreover, it can be shown that energy itself does not play a dominant role in explaining the considerable advances in human wellbeing over the past half century. Research analysing the resource requirements to fulfill universal basic human needs within a low carbon future will be presented. This research must take into account political, social and economic factors, since fulfilling human needs at low levels of resource use most likely requires a fundamental restructuring of social and economic systems alongside technological advances.

Integrating domestic political constraints in a global agreement on pollution reduction

A. Staes (1)
(1) Paris school of economics, Paris, France

One of the famous but unfortunately unsuccessful approaches to deal with global warming has been to create the emission trading system. While at first to be a hope, it failed by not taking into account asymmetric information and transaction costs associated. Mechanism designs coupled with incentives literature constitute the promising approach. To design optimal contracts, two major constraints appear: countries need to voluntarily participate and they need to provide optimal effort. Taking into account asymmetric information, the first best would be to implement a Martimort and Sand-Zantman model (2012) demonstrate there is a trade-off between the provision of incentives for participating countries and the provision of incentives to participate. To deal with this double free-riding problem, they design menu contracts such that all countries will participate to a fund but only the more efficient would provide efforts to reduce their emission. By taking into account the diversity of countries, global contracts reducing pollution below the non-cooperating level (also called 'business as usual level') could be proposed.

Martimort and Sand-Zantman model (2014) does not take into account domestic political constraints in the design of the global agreement. Starting from their model, my contribution attempts to open the "black box" of every government involved in negotiations. National governments face an asymmetric information issue: they are not perfectly informed about the firms' technologies (especially technologies to reduce emissions). Indeed, firms have an opportunistic rent, which is source of distortions. Government could try to collect information on firms -thought bureaucrats for instance. However, lobbying could try to capture bureaucracy. Avoiding capture for policies could be considered as "too-costly". The need to face these domestic constraints various mechanisms such as market or contracts should be considered at a domestic level.

Once taking into account domestic internal constraints, the setting up of general agreement mechanism could be modified. This analysis implies introducing double-edged incentives constraints to tackle asymmetric information issues both across and inside countries.

Research over contracts offers a way to focus on countries' different needs, maybe the more important issue that avoid any common agreement to be reached if denied. The integration of countries' internal political constraints makes more plausible the design of a global agreement. For that reason, this approach is relevant for the theme of day 4 “Collective action and transformative solutions".

Pathways to Deep Decarbonization in the United States by 2050

MS. Torn (1) ; JH. Williams, (2) ; B. Haley, (2)
(1) Lawrence Berkeley National Laboratory, Earth Sciences Division, Berkeley, CA, United States of America; (2) Energy and Environmental Economics (E3), San Francisco, United States of America

Limiting the anthropogenic increase in global mean surface temperature to less than 2 degrees Celsius will require a reduction in global net greenhouse gas (GHG) emissions on the order of 80% below 1990 levels by 2050. As a result, there is a growing need to understand what would be required to achieve deep decarbonization
in different economies. We examined the technical and economic feasibility of such a transition in the United States, evaluating the infrastructure and technology changes required to reduce U.S. GHG emissions in the year 2050 by 80% below 1990 levels. Using the PATHWAYS and GCAM models, we find that multiple alternative technology pathways exist to achieve this level of decarbonization in the U.S., assuming existing commercial or near-commercial technologies, natural replacement of infrastructure stocks, and one of a set of services and economic growth as a reference case based on the U.S. DOE Annual Energy Outlook. Reductions are achieved through high levels of energy efficiency (1.8 C$/2012), deep decarbonization of electricity generation (<20 gCO2/kWh), electrification of most end uses (>50% of final energy), and switching remaining end uses to lower carbon fuels. A highly granular annual infrastructure stock–rollover model shows the lifecycle of major capital assets and key technologies in power, transportation, buildings, and industry. A regional hourly dispatch model of the electricity system for high renewable, high nuclear, high CCS, and mixed scenarios shows that flexible production of fuels from electricity can simultaneously provide both supply–demand balancing for reliability in systems with high levels of inflexible generation (e.g., >75% renewable) and low carbon fuels for applications that are difficult to electrify. Incremental energy system cost is equivalent to <1% of gross domestic product (GDP) in the base case, with an interquartile range of -0.2% to +1.8% across a variety of technology portfolios and cost sensitivities, not including non-energy benefits from avoided climate change and air pollution. The future terrestrial carbon sink and the level of biomass feedstock that can be considered sustainable and low uncertainty for future energy sector emission reduction costs.

A dashboard and linked, top-down economic and bottom-up energy system models that demonstrate development indicators, technology deployment, investment and economic structure trajectories consistent with emissions pathways to achieve the 2°C goal

H. Trollip (1); T. Caetano (1); B. Merven (1); A. Hughes (1); H. Winkler (1)
(1) University of Cape Town, Energy Research Centre, Cape Town, South Africa

Global top-down models indicate that it is possible to achieve global emissions consistent with limiting climate–change warming over the 2015–2050 timeframe to 2 °C. This will require a fundamental techno–economic transformation towards low-carbon societies. However, across nations, historical, social, economical, political, and environmental conditions vary widely and thus credible transition pathways at national level require analysis using national data and proper consideration of national conditions. Similarly, national statistical, analytical and modeling resources and capabilities used to conduct this analysis vary widely. The global effort requires best possible analyses and methods that contribute to mitigation efforts. A South African team is working with the Deep Decarbonisation Pathways Project (DDPP), conducting such a national analysis. Teams participating in the DDPP have developed a method of analysis, representing more than 75% of global emissions. The timing of the initiative, and coordination of generation of results from the analyses are designed to support global processes such as the UN Climate Leaders Summit in September 2014 and the 21st COP in Paris.

Over the past two decades the Energy Research Centre (ERC) at the University of Cape Town has been building local capability to model the South African energy and economic systems. This includes aspects related to emissions consistent with contribution to achieving 2 °C. Building on its rich tradition of research into energy, economy, environment and development, the ERC has been developing a linked economic energy system and emissions model. The ERC team has particular interest in inclusion of development indicators in the analysis, as well as those for climate change. The inclusion of these indicators in the international dashboard is used to provide a common set of data for national and regional analysis and also provides a full set of economic, system and emissions data for the pathways. In addition to providing results coordinated to support global processes the novel combination of a dashboard and linked model provides a unique economic energy perspective. The energy system models also provides impetus and direction necessary to identify key issues to focus efforts for further model refinements and development for ongoing support of these processes, and national level processes.

To support the DDPP the team has worked to provide results consistent with the global initiative while also focusing on model development and data for informing the development indicators. This novel approach of combining data on multiple issues from multiple sources and tailoring models to address specific South African issues such as high unemployment, existing socioeconomic structures, labour force skills profiles and skills development scenarios, and options for future economic structures and non-energy benefits from avoided climate change and air pollution. The DDPP results are providing similar analyses for countries representing more than 75% of global emissions. The ERC team has particular interest in inclusion of development indicators in the system and emissions model. The ERC has been developing a linked economic energy system, economy, environment and development, achieving 2 °C. Building on its rich tradition of research into energy, economy, environment and development, the ERC has been building local capability to model the South African energy and economic systems. This includes aspects related to emissions consistent with contribution to achieving 2 °C. Building on its rich tradition of research into energy, economy, environment and development, the ERC has been developing a linked economic energy system and emissions model. The ERC team has particular interest in inclusion of development indicators in the analysis, as well as those for climate change. The inclusion of these indicators in the international dashboard is used to provide a common set of data for national and regional analysis and also provides a full set of economic, system and emissions data for the pathways.

Back to the future: Assessing the risks of 2°C pathways

C. Von Stechow (1); J. Minx, (1); K. Kriaih (2); D. McCollum (3); J. Jewell (4); G. Baiocchi (5)
(1) MCC Berlin, Berlin, Germany; (2) International Institute for Applied Systems Analysis, Energy Program, Luxenberg, Luxembourg, Austria; (3) IIASA, Laxenburg, Austria; (4) IIASA, Laxenburg, Austria; (5) University of Maryland, College Park, United States of America

According to the most recent contribution of the IPCC, decision makers have some flexibility in terms of climate change mitigation timing and technology choices to achieve ambitious climate targets such as the 2°C target. At the same time, they would like to pursue multiple other objectives beyond climate change mitigation that are affected by mitigation timing and technology choices. Depending on locally specific priority settings and risk perceptions, this could imply delaying mitigation efforts and/or ruling out specific technologies compared to the globally most cost-effective mitigation pathways and technology portfolios analyzed by Integrated Assessment Models (IAMs). Understand the implications of deviating from these cost–effective mitigation pathways for other risks related to mitigation choices could allow national decision makers to trade off various risks and priorities in a more informed way when choosing their mitigation policies.

On a global level, alternative mitigation pathways based on IAMs are primarily characterized by (i) the probability of exceeding a pre–determined temperature threshold and its the high aggregated economic costs of reaching that temperature threshold. Some studies have also analyzed (i) the potential co–benefits for non–climate objectives (such as energy security and air quality) and (ii) the risks for non–climate objectives (such as land availability and food security). While the first two characteristics have been in the focus of recent model intercomparison projects and scientific assessments (e.g. WGIII AR5/UNEP), and the benefits of reaching 1.5 °C compared to 2 °C have gained prominence (see, e.g., the Global Energy Assessment), the risks of alternative global mitigation pathways have attracted less attention – possibly except food security – in the literature. This change in focus is mainly driven by two reasons: (i) Mitigation risks are challenging to quantify, let alone monetize, on a global level – the discussion thus usually focuses on technology–specific risks, such as those associated with nuclear power or CO2 capture. (ii) While the mitigation risks tend to be smaller, less persistent, less prevalent, less irreversible and hence better manageable compared to the risks of unabated climate change (see IPCC AR5 SYR).

This paper aims at improving our understanding of mitigation risks for choosing amongst alternative ambitious mitigation pathways. To this end, the paper will first review literature that has used various IAM outputs to discuss those challenges to mitigation pathways that have a bearing on risks for non–climate objectives and will hence serve here as
risk indicators for attaining/failing these objectives. In contrast to existing studies that focus on specific challenges or IAMs, this paper will proceed to analyze risk profiles of alternative mitigation pathways across a more comprehensive set of risk indicators most directly linked to other non-climate objectives, drawing on multi-model outputs from recent IAM intercomparison projects.

The ambition of the paper is to shed light on the risk tradeoffs involved in pursuing policies not consistent with the most cost-effective mitigation pathways to limit global warming to below 2°C. For instance, recent advances in the IAM literature stress that delaying mitigation efforts beyond 2030 will lead to a lock-in of high-carbon and high energy demand development pathways and hence mitigation costs. But these scenario results have not yet been used comprehensively to evaluate the risks of mitigation efforts on a large set of other framed climate objectives, particularly not in combination with additional technological constraints and/or assumptions for ambitious energy intensity improvements. This paper wants to address this research gap and show in what way the flexibility of future decision makers in choosing climate policy consistent with the 2°C target will be reduced by climate policy decisions today.

Based on a preliminary evaluation of the scenario results, the paper puts forward that delaying mitigation as well as cutting out technologies from the portfolio of mitigation options could lead to problematic risk trade-offs for future decision makers that have to balance increasingly high risks of unabated climate change and increased mitigation needs for those technologies still in the table. These results could serve as a basis for developing new approaches to climate policies more adapted to locally specific priority settings and risk perceptions without endangering globally agreed climate targets.

4403 - Revising the 2015 Paris Climate Change Agreement architecture for better governance and outcomes

ORAL PRESENTATIONS

O-4403-01

«Revising the 2015 Paris Climate Change Agreement Architecture for Better Governance and Outcomes» Session chair

J. De Melo (1)
(1) Ferdi, Clermont-Ferrand, France

The Durban platform calls for “strengthening the multilateral rules-based regime under the [UNFCCC] convention”. Issues of particular importance still to be decided are the particular legal form to be applied; if elements of the legal form are to be legally binding; how responsibilities are to be balanced across and among developed and developing countries; and the agreement’s role, if any, in regulating or facilitating international emissions trading. Of the three approaches to choose from (expanded Kyoto-like approach, legalization of the Cancún architecture, multi-track approach), this session will focus on aspects of a multi-track approach. This approach would allow a variable geometry with developing and developed countries involved in different parts of the overall regime. [1]

The session is built around the observation that the climate regime needs innovative modes of governance that recognize that the current regime is a transnational regime complex that is increasingly inadequate for inter-state governance. The chair will first note that the speakers’ session will build on and bring together clubs of firms/cities/States that are conducive to the goal of building confidence (e.g. tackling easier problems such as soot with co-benefits; start linking with like systems to build confidence; designing smart border measures). This confidence-building approach is needed to build the collective action that has eluded the climate regime so far.

The chair will close by taking the example of the ongoing negotiations on an Environmental Goods Agreement (EGA), a good example of the three elements that are needed for a successful climate agreement. First, the treaty must encourage and promote full participation by countries. Second, the treaty must demand that parties change their behaviour substantially. Third, the treaty must provide parties with an incentive to comply with the obligations they have pledged to fulfil. Depending on the willingness of the parties engaged in the ongoing negotiations which should be concluded prior to the COP21, the EGA could turn out to be the first global climate agreement. [2]


identifying regime complexes and analyzing their effects» (Orsini, Morin & Young).

Our contribution will try to give a legal analysis of the regime complex for climate change, which has been until now mainly defined and characterized by international relations and political scientists.

After a legal mapping of the regime complex for climate change, the contribution will wonder what role could play the Paris accord in the «de-fragmentation» of the climate regime. Beyond the well-known finding of a fragmented, polycentric and complex international climate governance, how to build a more integrated and effective regime complex on climate change? Much of the institutional innovation in regime complexes arises at the joints between regime elements. By drafting the Paris accord, negotiators should attempt to build partnerships between various elements of networks of norms and actors. Finally, how to inject new life into the global community’s response to climate change? Through systematic links ethical or institutional, formal or informal) to other regimes like for example the trade regime, the ozone regime or the biodiversity regime?

Our work forms part of a collective interdisciplinary project funded by the French National Research Agency and named CIRCULEX (Circulations of Norms and Actor Networks in Global Environmental Governance -ANR-12-CLOB-0001-03 CIRCULEX-). Concerning the international regime complexes for climate change and biodiversity, the first objective of CIRCULEX is to highlight the plurality of sites of governance and formal and informal links between them. This work highlights the diversity of actors involved and their modes of interconnection, as well as the diversity of standards that circulate in the complexes, in terms of origin, content and scope. A first set of connections could be drawn about the internal dynamics of regime complexes, conflicts and convergence of standards and interconnections with other regimes. We describe also the modalities of circulation of norms and experts in the regime complexes, and measure the permeability of economic actors to environmental governance standards, evaluate the interrelationships between public and private actors in the regulation. Finally, our project highlights the importance of norms and networks of actors on the functioning of regime complexes, especially in terms of implementation and effectiveness. Does permeability favor a greater effectiveness of regimes or not?

O-4403-04

The role of the trade system in promoting climate action

S. Hawkins (1) ; R. Meléndez-Ortiz (2) ; I. Jegou ()
(1) International Centre for Trade and Sustainable Energy, Climate & Energy, Geneva, Switzerland; (2) ICTSD, Geneva, Switzerland

COP21, scheduled for December 2015 in Paris, is expected to deliver a “protocol, another legal instrument or an agreed outcome with legal force under the Convention applicable to all Parties”. The exact shape of the future climate change architecture is still to be defined, the work under the ADP, including the INDC-process, indicates that we are heading towards an approach of best-endeavor pledges by countries on individual mitigation contributions.

An advantage of this scenario is that it gives much leeway to countries to design and implement climate policies which suit their individual situations, needs and capacities. Among the challenges to be addressed are first how to ensure that the individual contributions add up to an ambitious enough response to climate change, and second that they are if not coordinated so at least mutually supportive.

In this context, the emergence of collaboration between groups of countries in "clubs" is an interesting and noteworthy development. Indeed, framing climate deals in smaller groups, designed in a way that encourages expression of membership and linkages among groups over time, could be an effective way forward which complements multilateral efforts and reinforces the dynamic towards reaching collective agreements.

Taking into account the complexity of designing deals in the UN-oriented system of diplomacy, encouraging smaller club-like initiatives could contribute to the larger climate goal.

A recent ICTSD paper[1] identifies six main tasks that clubs could perform. They could provide a forum for enthusiastic countries to “do the deals” that would get reluctant countries to make bigger efforts; play a role in designing smart Border Carbon Adjustment Measures, BCAs; craft conditional commitments; craft and demonstrate technology strategies; tackle easier problems and last, learn how to help countries adapt.

In order for clubs to be effective and eventually attract new members, they will need to rest on coercion and on positive incentives working to ensure the realization of real gains. In this context, there may also be a need to develop benefits that are exclusive to club members. In the area of climate change, this is particularly challenging as the main gain of joint action on mitigation is aggregate emissions abatement, the benefits of which accrue to the whole world.

The possible linking of clubs, as well as the creation of certain exclusive benefits, are pertinent questions with respect to the world trade system. Can and should trade governance play a pro-active role to promote and facilitate the interplay between clubs, and if yes in what respect?

This intervention, based on recent and upcoming work in ICTSD, in particular under its joint E15-initiative, will address such questions. [2]


O-4403-05

Internal coherence of the Paris outcome and connections to other regimes: conditions for confidence, cooperation and ambitious action for climate

T. Ribera (1)
(1) Institute for Sustainable Development and International Relations, Paris, France

From the experience of the last Conferences of the parties to the UNFCCC, many things have changed in a very short time. Climate negotiations are not any more to be considered a zero sum game, but we are now looking to gather all countries in order to strengthen cooperative approaches, learning processes and mutual reinforcement of each one’s efforts towards their own decarbonized and climate resilient future. The big challenge is how to consolidate confidence, among governments and also from other stakeholders, both on the ability of governments to act and implement climate policies now, and on the ability to build a consistent framework to incentivize further and more ambitious action in the future.

This means, a least, two new streams of work. The first one could be defined as a positive differentiation within the multilateral platform: how to integrate plurilateral action in the multilateral context in order to ensure a common learning process from plurilateral experiences and benefiting from the expertise of the countries that have managed to gather all countries in order to strengthen cooperative approaches, learning processes and mutual reinforcement of each one’s efforts towards their own decarbonized and climate resilient future. The big challenge is how to consolidate confidence, among governments and also from other stakeholders, both on the ability of governments to act and implement climate policies now, and on the ability to build a consistent framework to incentivize further and more ambitious action in the future.

This means, a least, two new streams of work. The first one could be defined as a positive differentiation within the multilateral platform: how to integrate plurilateral action in the multilateral context in order to ensure a common learning process from plurilateral experiences and benefiting from the expertise of the countries that have managed to gather all countries in order to strengthen cooperative approaches, learning processes and mutual reinforcement of each one’s efforts towards their own decarbonized and climate resilient future. The big challenge is how to consolidate confidence, among governments and also from other stakeholders, both on the ability of governments to act and implement climate policies now, and on the ability to build a consistent framework to incentivize further and more ambitious action in the future.

This means, a least, two new streams of work. The first one could be defined as a positive differentiation within the multilateral platform: how to integrate plurilateral action in the multilateral context in order to ensure a common learning process from plurilateral experiences and benefiting from the expertise of the countries that have managed to gather all countries in order to strengthen cooperative approaches, learning processes and mutual reinforcement of each one’s efforts towards their own decarbonized and climate resilient future. The big challenge is how to consolidate confidence, among governments and also from other stakeholders, both on the ability of governments to act and implement climate policies now, and on the ability to build a consistent framework to incentivize further and more ambitious action in the future.

This means, a least, two new streams of work. The first one could be defined as a positive differentiation within the multilateral platform: how to integrate plurilateral action in the multilateral context in order to ensure a common learning process from plurilateral experiences and benefiting from the expertise of the countries that have managed to gather all countries in order to strengthen cooperative approaches, learning processes and mutual reinforcement of each one’s efforts towards their own decarbonized and climate resilient future. The big challenge is how to consolidate confidence, among governments and also from other stakeholders, both on the ability of governments to act and implement climate policies now, and on the ability to build a consistent framework to incentivize further and more ambitious action in the future.

This means, a least, two new streams of work. The first one could be defined as a positive differentiation within the multilateral platform: how to integrate plurilateral action in the multilateral context in order to ensure a common learning process from plurilateral experiences and benefiting from the expertise of the countries that have managed to gather all countries in order to strengthen cooperative approaches, learning processes and mutual reinforcement of each one’s efforts towards their own decarbonized and climate resilient future. The big challenge is how to consolidate confidence, among governments and also from other stakeholders, both on the ability of governments to act and implement climate policies now, and on the ability to build a consistent framework to incentivize further and more ambitious action in the future.

This means, a least, two new streams of work. The first one could be defined as a positive differentiation within the multilateral platform: how to integrate plurilateral action in the multilateral context in order to ensure a common learning process from plurilateral experiences and benefiting from the expertise of the countries that have managed to gather all countries in order to strengthen cooperative approaches, learning processes and mutual reinforcement of each one’s efforts towards their own decarbonized and climate resilient future. The big challenge is how to consolidate confidence, among governments and also from other stakeholders, both on the ability of governments to act and implement climate policies now, and on the ability to build a consistent framework to incentivize further and more ambitious action in the future.

This means, a least, two new streams of work. The first one could be defined as a positive differentiation within the multilateral platform: how to integrate plurilateral action in the multilateral context in order to ensure a common learning process from plurilateral experiences and benefiting from the expertise of the countries that have managed to gather all countries in order to strengthen cooperative approaches, learning processes and mutual reinforcement of each one’s efforts towards their own decarbonized and climate resilient future. The big challenge is how to consolidate confidence, among governments and also from other stakeholders, both on the ability of governments to act and implement climate policies now, and on the ability to build a consistent framework to incentivize further and more ambitious action in the future.
P-4403-01
Avoiding dangerous climate change: the role of shipping in delivering on the IPCC’s latest carbon budgets
K. Anderson (1); M. Traut (1); A. Bows-Larkin (1)
(1) Tyndall Centre for Climate Change Research, University of Manchester, Manchester, United Kingdom

In 2015 and with global emissions rising at unprecedented rates one clear certainty is that the future will be very different from the past. Whether the world continues to follow a trajectory of greenhouse gas emissions exceeding those in RCP8.5, the highest in the IPCC’s suite of scenarios and associated with an expected temperature increase of between 3°C and 5°C, or whether we begin a programme of stringent mitigation, is a decision for the international community. These two paths lead to very different futures, each radically different from the past. This paper reflects on and analyses the role of the global shipping industry as an important player in both these potential futures.

The Kyoto Protocol has called on the International Maritime Organisation (IMO) to "... [control greenhouse gas emissions] from shipping". In 2009, the then secretary general of the IMO concluded that "our collective way of life has become unsustainable" and stressed "the need to make some tough decisions ... and ... to start putting life above all". In stark contrast, the baseline results of recent shipping emissions scenarios in the 2nd IMO GHG Study (2009) have CO2 emissions between 2007 and 2050 rise by a factor of between 2.2 and 3.1. Similarly, the 3rd IMO GHG Study (2013) presents a suite of sixteen scenarios, with rises of up to 3.5 times those estimated for 2012.

It is important to note that the updated emissions estimates in the 3rd IMO GHG Study (2014) demonstrate a fall in CO2 over the period 2007 to 2012. It argues that much of this emission reduction was due to slow steaming in response to a global economic downturn. Recent emissions reductions may therefore represent "latent CO2", that could be realised once the economic situation changes and vessels revert to pre-crisis speeds.

The paper contrasts the different emissions pathways for the shipping sector, placing them in the quantitative context of global emissions scenarios and associated temperature responses. It concludes that steering a mitigation course has never been more critical, nor the choice more stark.

P-4403-02
Opportunities and challenges for decarbonising the shipping sector
W. Conover (1)
(1) Tyndall Centre for Climate Change research, Manchester, United Kingdom

The growth in transport emissions poses a particular challenge in meeting wider 2 °C emission targets. The demand for shipping experienced a significant period of growth during the first half of the previous decade, prompted by growth in regions such as Asia in conjunction with an increasing trade in manufactured material and dry bulk goods. This incentivised speculative ordering of new ships which meant that the fleet experienced over-capacity during the subsequent reduction in demand during the economic downturn. The third greenhouse gas report commissioned by the IMO estimates that between 2007 and 2010 CO2 emissions due to international transport decreased by 13%. This can be attributed to an increase in the size of ships (in conjunction with a reduction in demand) represent an opportunity to reduce the emissions associated with the shipping sector.

As the ships which experienced the greatest reduction in speed appeared to be the fastest ships, (such as large container vessels) it could be argued that such vessels will have the most to gain by resuming pre-existing speeds once demand returns. Therefore the cyclical nature of the shipping sector provides an opportunity to realise opportunistic emissions reductions but does make realising long term savings difficult. Through the generation of alternative scenarios for future global shipping emissions, this study seeks to better understand the internal and external to the shipping sector, which may assist or hinder it in reducing its emissions, commensurate with meeting wider 2 °C targets, which require a significant reduction in carbon dioxide emissions.

Furthermore as shipping remains a derived demand, changes to existing trading patterns will influence the extent to which the sector can decarbonise. However the shipping sector itself cannot readily influence the demand for trade. Scenario results show that under a different decarbonisation scenarios, a reduction in fossil fuel trade may be compensated for by an increase in biomass trade, or the successful implementation of carbon capture and storage technology may allow fossil fuel trade to continue. A scenario in which the future demand for trade is projected to increase makes decreasing the carbon intensity of shipping even more important. In that regard, decarbonisation cannot be envisioned without penetration of both appropriate technologies and the availability of alternative low carbon fuels. The scenario emissions reduction necessary implies that widespread uptake of new-build and retrofit technology will be necessary. The efficiency of former vessels may be improved through energy efficiency upgrades, which also reflect fluctuations in the shipping market. Supporting technological uptake will necessitate the availability of appropriate financing and opportunities to develop the uptake of new technologies. This will require identification of the most appropriate technological solutions, such as identifying the optimal routes for the application of wind technology. However lack of available berth space as well as a lack of appropriate training can impede the uptake of retrofit technologies.

Despite the scale of the challenge, the shipping sector arguably has greater opportunity to decarbonise than other sectors, such as aviation sector. However, given the urgency, it is imperative to identify synergies which may assist in sectoral decarbonisation in the near term. A reduction in the level demand for shipping vessels which may assist in sectoral decarbonisation in the near term. A reduction in the level of shipping demand, in conjunction with an increase in ship size will make a reduction in speed more viable, which can have the potential to impact on low carbon technologies. Modifying the conditions of vessel hire or enhancing supply chain flexibility will also assist in making fuel savings more attractive and viable. In summary, allowing shipping to reach its commitments within a 2 °C framework may not be wholly within the gift of the sector itself and will require support from the wider system of which shipping is a reactive part.

P-4403-03
Geography of International Trade, Maritime Transport and Climate Change in XXI Century: A Descriptive Basis for Multilateral Action from a South Perspective
E. Tancredi (1)
(1) Universidad Nacional de Lujan, Departamento de Ciencias Sociales, Lujan, Argentina

This paper puts the focus of its analysis in the relationship among the main tendencies of the international trade of goods, the essential characteristics of the seaborne trade and the challenges of climate change. From the beginnings of the XXI century, three economic characteristics can be pointed out. First, the significant expansion of the global value chains that represent the new form of disintegration and integration of the local production and consumption of goods and services which has driven to a new international division of the production (WTO, 2014). Second, the deepening of the regional integration and the cooperation South–South that reconfigure the sectorial unequal relationships between the North and the South. In third place, the exponential growth of commercial exchanges. In this context, 80% of the world trade is carried out by maritime means. Some South-South routes have been diversified due to technological improvements and transport efficiency. Marine routes have been enlarged and new ones have been open (i.e. Channel of Panama and Artico routes). While some emergent economies (specifically in South Asia) reorient their exports toward medium and...
high technological incorporated manufactures, many other monopolize their exports in agricultural products or mineral resources. Volumes expanded at the rate of 3.8% of nearly 9.6 billion tons. Of these shipments, dry cargo (major and minor dry commodities carried in bulk, general cargo, breakbulk and container trade) accounted for the largest share (70.2%), followed by tanker trade (crude oil, petroleum product and gas) which held a 29.8% share (UNCTAD, 2014). Developing countries have increased their contribution to these flows, although in an unequal distribution at individual terms. Regionally, Asia remained the main loading and unloading area in 2013 with its share of imports (unloading) being particularly dominant. Americas is the other major loading area and Europe on the unloading side. These shares are likely to further evolve with changing trade patterns and partners, the emergence of Africa and developing America as areas with a significant growth potential, and fast growing trade on secondary container trade routes supporting South-South and intraregional trade. Global containerized trade is projected to grow, given among other factors by improved prospects for mainlane East-West trade. The global fragmentation of the production and the development of multimodal systems of international transport are the elements that also lead to a reorganization of the ports. In this context, the sector of marine transport needs to adjust its commercial strategies to adapt to the changes of the world economy and rules of the trade, besides risks and current environmental uncertainties. As world seaborne trade increases, the main challenges – especially from the perspective of a social and environmentally sustainable development, as well as from the point of view of the transport and trade facilitation – consist in reducing the GHG (mainly CO2) emissions from international shipping and define mitigation and adaptation policies. In terms of CO2 emissions, transport, in particular marine transport is the more effective one. Nevertheless, due to its enormous scale, it is estimated that ship emissions (especially from oil-tankers and container ships) represent 11.8% of the emissions of the transport sector and 1.6 to 4.1% of the CO2 world emissions resulting from burning; according to the International Maritime Organization (OMI), they will increase in a factor from 2,4 to 3 between 2007 and 2050 (UNCTAD, 2008, OMI, 2009). This linking of climate change challenges with the tendencies of international seaborne trade and their emissions of GHG have relatively little presence in the multilateral negotiations. But OMI has recently adopted a group of technical and operative measures to improve the energy efficiency and of GHG emission from ships with the aim to promotes trade but in turn energy efficiency and sustainable development, according to the principle of the common but differed responsibilities among developed and developing countries. In this sense then, it is sought to advance in this proposal a detailed characterization of the main tendencies of international trade and seaborne trade in the XXI century, analyzing their complex links with climate change, and the main challenges for a negotiated multilateral action, putting the accent, as case analysis, in the emergent economies of Latin America (in particular Brazil, Mexico and Argentina).

4404 Climate finance: New sources, new instruments, more effects?

ORAL PRESENTATIONS

K-4404-01

Sources and instruments for climate finance
A. Torvanger (1)
(1) CICERO, Oslo, Norway

Long-term investments in climate-friendly and climate change resilient infrastructure, buildings and energy is essential to mitigate greenhouse gas emissions and adapt to climate change impacts. Such climate finance is particularly in need in many developing countries due to limited economic resources and expected impacts from climate change. Direct government contributions can help, but a large share of the agreed 100 Bill. USD annually from 2020 for climate measures in developing countries can only realistically come from the private sector.

What is the status of sources and channels of long-term climate finance? I present a new status report on the most promising sources of climate finance. Relevant sources are public carbon-related revenues (taxes and emissions trading), carbon offset markets, international transport, removal of fossil subsidies, direct budget contributions, finance development institutions, private flows, green bonds, ‘debt-for-climate’ swaps, and export credits.

What can developed country governments do to catalyse private sector development in climate finance? Should there be a range of de-risking interventions and instruments available, from credit enhancement to guarantees.

Green bonds finance low-carbon or climate-robust projects. Private sector investment in green bonds has tripled in each of the last two years. Pension funds, insurance companies, and socially responsible investors are increasingly investing in green bonds. Can the momentum of the green bond market be harnessed to make a real difference to the climate and for climate finance in developing countries? Can Green Bonds funding be significant growth in bilateral climate finance such as the Green Climate Fund?

Key issues discussed are:

- What are the most promising sources of climate finance?
- What is the scope for government de-risking of private finance?
- What government measures are most efficient to stimulate private finance?
- To what extent can Green Bonds make a difference in climate mitigation and adaptation?
- How can Green Bonds be adapted to the needs of developing countries?
- How can governments facilitate Green Bond investments in developing countries?

Mobilising capital for green infrastructure investments
C. Kaminker (1)
(1) OECD, Environment Directorate, Paris, France

A keynote presentation focusing on OECD analysis on what developed country governments can do to catalyse private sector investment in green infrastructure of developing countries.

The presentation would cover key lessons from the following OECD work streams: Mapping Channels to Mobilise Institutional Investment in Sustainable Energy: An OECD Report for G20 Finance Ministers and Central Bank Governors; which uses an empirical base of 70 deals to identify barriers and advise on how governments can overcome them to mobilise institutional investment in sustainable energy and how governments can support the development of potentially promising investment channels and consider policy interventions that can make institutional investment in sustainable energy infrastructure more likely.

Green Bonds: a new report will analyse the potential, barriers and policy solutions for scaling up green bonds across their various different forms (including municipal, corporate, asset-backed, covered, project).

The OECD-led Research Collaborative on Tracking Private Climate Finance, OECD-led network of governments, research institutions and international finance institutions. Over the past two years it has explored data and a range of methods to estimating private finance mobilised by developed countries for climate action in developing
countries. In 2015, work conducted under and in co-operation with the Research Collaborative will focus on the further development and ground-testing of estimation methods in the context of pilot measurements of mobilisation for climate–relevant sectors, different types of interventions/instruments, as well as at the level of individual/groups of countries and public finance institutions.

The OECD Policy Guidance for Investment in Clean Energy Infrastructure: Expanding Access to Clean Energy for Green Growth and Development is a good example of our efforts to improve the enabling conditions for private investment in clean energy infrastructure. Non-prescriptive tool to help governments identify ways to mobilise private sector investment in clean energy infrastructure, annexed to the Communiqué of G20 Finance Ministers in 2013.

OECD report on Overcoming Barriers to International Investment in Clean Energy discusses the rise of hidden indirect protectionism in clean energy since the 2008 financial crisis. The report provides empirical evidence on the negative impact that LCRs have on international investment in solar PV and wind energy, as they increase the cost of inputs for downstream segments of the value chain like renewable energy–based electricity generation. By assessing the impacts of measures such as LCRs across different segments of the value chain, this report provides policy-makers with evidence-based analysis to guide their decisions in designing clean energy support policies.

O-4404-01

Result Based Financing for Mitigation: choosing the right “triggers” to drive a “paradigm shift”

R. Spalding-Fecher (1)
(1) Carbon Limits AS, Pelham, United States of America

Result-based finance is an emerging tool to link public and private financing to a more sustainable and climate-friendly future. The main goal of many of these new funding sources is to create a “paradigm shift” towards low-carbon and climate-resilient development. The question is: does this mean for how new mitigation financing could be allocated and what types of projects, programmes or larger policy changes could be targeted? This contribution explores two specific questions in the RBF decision making process. First, how can we ensure that RBF for climate finance promotes mitigation even after the payments for emissions reduction stop, and supports technologies and practices that will continue to be financed and maintained for climate stabilization? Long term results typically require policy and institutional changes, which are not normally linked to project or programme-based financing. In addition, focusing on long term results means designing technology “lock in” and driving innovation in mitigation technologies. The second question is what type of non-climate criteria are needed to ensure RBF, including environmental and social safeguards, and how might these be integrated in the payment system. In other words, how might non-climate impacts not only be monitored, but how would their achievement (or avoidance) affect the results-based payments.

O-4404-02

Smart Unconventional Monetary (SUMO) policies: giving impetus to green investment

R. Morel (1); B. Leguet (1)
(1) CDC Climat, PARIS, France

Today, given the amount of investment needed to reach a 2–degree emissions reduction target and the tight budgetary constraints of governments worldwide, public spending alone will not be sufficient alone. Therefore, there is a strong need to not only shift private financial flows from “brown” sectors to “green” sectors, but also to leverage new sources of financing. Addressing the second challenge, this study reviews three families of proposed funding mechanisms based on unconventional monetary policies targeting “green” or “climate” investments. These “Smart Unconventional Monetary” (or SUMO) policies include: (i) the use of Special Drawing Rights (SDRs) issued by the International Monetary Fund (IMF); (ii) green quantitative easing and (iii) the issuance of Carbon Certificates.

This contribution will present the first basic elements of these three approaches. It will then identify and discuss the implementation challenges to overcome. These include both concerns over their difficulties to reach multilateral agreements in the short run, and the involvement of the private sector. Finally, the presentation will look at the key conditions for ensuring the environmental integrity of the unconventional monetary policies, both ex-ante – during the selection of eligible projects – and ex-post. This contribution will look at lessons drawn from Monitoring, Reporting and Verification (MRV) methods used in the Clean Development Mechanism as well as other existing schemes (white certificates, etc.).

P-4404-01

Public Financial Institutions and the Low-Carbon Transition: Five Case studies on Low-Carbon Infrastructure and Project Investment

I. Cochran (1); V. Marchal (2); R. Hubert (1); R. Youngman (2)
(1) CDC Climat, Paris, France; (2) OECD, Climate, biodiversity and water division, Paris, France

This study, jointly undertaken by the OECD and CDC Climat Research, analyses the role of Public Financial Institutions (PFIs) in fostering the low-carbon energy transition through domestic climate finance activities. The study maps the key tools and instruments currently used by five institutions to mobilise private sector investment in low-carbon infrastructure projects in OECD countries in three sectors: sustainable transport, energy-efficiency and renewable energy. Between 2010–2012, these five institutions – Group Caisse des Dépôts in France; KfW Bankengruppe in Germany; the UK Green Investment Bank; the European Investment Bank and the European Bank for Reconstruction and Development – have provided over 100 billion euros of equity investment and financing for energy efficiency, renewable energy and sustainable transport projects. The results of the study indicate that these institutions play a key role in leveraging private sector participation in low-carbon, climate-resilient investment through the use of traditional and innovative approaches to link low-carbon projects with finance through enhancing access to capital; facilitating risk reduction and sharing; improving the capacity of market actors; and shaping broader market practices and conditions.

P-4404-02

Tracking low-carbon investment in France in 2011: a landscape of sources, flows and channels

R. Morel (1); I. Cochran (1); R. Hubert (1)
(1) CDC Climat, PARIS, France

This report presents the first comprehensive view of climate finance flows in France to reduce GHG emissions. Funding for the energy transition is a central issue for which the available data is often not reliable. This report aims to further the current debate by providing economy-wide estimates. This study identified and analyzed the investment spending in France in 2011 that contributed directly or indirectly to the reduction of greenhouse gases emissions (GHG); this corresponds to investment in low-carbon infrastructure and fixed assets (renewable energy, building high environmental quality, public transport, etc.). This information has been used to identify the distribution of flows across sectors, the share of different instruments, their use and the role of different actors.

This analysis has identified EUR 22.2 billion of investment in France in 2011 in physical or tangible assets that reduce greenhouse gas emissions. Across all sectors, renewable energy accounted for EUR 9.0 billion of investment, including investment subsidies of 1.0 billion EUR. Energy efficiency was the second largest area of climate investment, totaling EUR 8.3 billion. The share of grants and concessional loans – with thus a cost for the public sector – totaled EUR 2.3 billion. These investments are
We implement a decentralized tax system. To our knowledge, our model is the first to combine the economics of exhaustible resources on the other. Using a numerical general equilibrium model we compute optimal tax portfolios and precisely assess their opportunity costs. Our contribution is thus twofold. First, we bridge the observed effects show that a unilateral tax reform which does not affect decisions about fiscal policy. Nevertheless, these effects complemented by a rising share of labor taxes, give evidence of the resulting race-to-the-bottom. The fact that this race-to-the-bottom impedes a government’s ability to raise sufficient funds has far reaching consequences. Funds are required, e.g., not only for health care or education, but also for productive public infrastructure, which is important for both efficiency and equity. Accordingly, an emerging consensus in the empirical literature suggests that these stocks are underfinanced. This raises the question how to reduce exposure to tax competition and generate funds to finance essential public goods.

We identify taxes on the use of carbon resources as a superior alternative to capital taxes. Even though fossil resources are also traded internationally, there is an asymmetry in efficiency between capital and resources as tax base. While ownership of fossil resources gives rise to a rent, capital does not. Taxes on either factor cause an intertemporal reallocation by driving economic behavior out of countries with relatively high tax rates. The carbon tax has the advantage, though, of capturing part of the resource rent. Governments can use the appropriated rent for productivity enhancing infrastructure investments, which in turn attracts investments in domestic capital stocks.

Further, it turns out that a carbon tax may not only have fiscal benefits. When the motivation to tax the use of fossil resources is based exclusively on fiscal needs, then resource exporters react by reducing both the rate of fossil resource extraction and the amount of resource extraction (a volume effect). Thus, carbon taxes do not cause a green paradox in this situation, but can be part of an effective green tax reform. Governments may not take climate externalities into account, as modeled in our paper. In that case, timing and volume effects per se do not affect decisions about fiscal policy. Nevertheless, these observed effects show that a unilateral tax reform which introduces a carbon tax also has beneficial environmental implications.

Our contribution is thus twofold. First, we bridge the gap between horizontal fiscal federalism, in particular the tax competition literature on the one hand, and the economics of exhaustible resources on the other. Using a numerical general equilibrium model we compute optimal tax portfolios and precisely assess their opportunity costs. To our knowledge, our model is the first to combine the following key features. We implement a decentralized market economy with several representative agents and strategically interacting governments. The tax instruments, which governments use to finance productive infrastructure stocks, are determined endogenously for both cooperative and non-cooperative behavior in the Nash equilibrium. Capital and fossil resources are traded on international markets and, we work with the dynamics of capital accumulation and resource extraction (based on the respective models of Frank P. Ramsey and Harold Hotelling). Second, we shed light on the supply side dynamics of fossil resource extraction. So far, most of the research on the conditions under which a green paradox occurs has used partial equilibrium analysis. Only recently has this strand of literature been extended to general equilibrium. Now, we take even one step further. Our model allows strategic interactions between fossil fuel selling and buying countries, as well as among the governments of buying countries themselves. We conclude that even when governments do not intend to address climate change, they still have an incentive to implement a carbon tax to improve their fiscal policy. Then, the carbon tax nevertheless helps mitigating the adverse effects of climate change. It is thus not only the environmental ministers who should favor carbon taxes, but also the ministers of finance.

Why finance ministers might favor carbon taxes, even if they do not believe in climate change
O. Edelhofer (1); M. Franks, (2); K. Lessmann (3)
(1) Potsdam Institute for Climate Impact Research, Potsdam, Germany; (2) Potsdam Institute for Climate Impact Research (PIK), Potsdam, Germany; (3) Potsdam Institute for Climate Impact Research, Sustainable solutions, Potsdam, Germany

The economic forces of globalization constrain democratic governments increasingly. According to Dani Rodrik, we cannot have democracy, national sovereignty and hyperglobalization at the same time (Rodrik, 2011)[1]. Hyperglobalization impinges on democratic choices within sovereign nations by giving rise to corporate tax competition, which "restricts a nation's ability to choose the tax structure that best reflects its needs and preferences" (ibid., p. 193). Declining corporate tax rates, complemented by a rising share of labor taxes, give evidence of the resulting race-to-the-bottom. The fact that this race-to-the-bottom impedes a government’s ability to raise sufficient funds has far reaching consequences. Funds are required, e.g., not only for health care or education, but also for productive public infrastructure, which is important for both efficiency and equity. Accordingly, an emerging consensus in the empirical literature suggests that these stocks are underfinanced. This raises the question how to reduce exposure to tax competition and generate funds to finance essential public goods.

We identify taxes on the use of carbon resources as a superior alternative to capital taxes. Even though fossil resources are also traded internationally, there is an asymmetry in efficiency between capital and resources as tax base. While ownership of fossil resources gives rise to a rent, capital does not. Taxes on either factor cause an intertemporal reallocation by driving economic behavior out of countries with relatively high tax rates. The carbon tax has the advantage, though, of capturing part of the resource rent. Governments can use the appropriated rent for productivity enhancing infrastructure investments, which in turn attracts investments in domestic capital stocks.

Further, it turns out that a carbon tax may not only have fiscal benefits. When the motivation to tax the use of fossil resources is based exclusively on fiscal needs, then resource exporters react by reducing both the rate of fossil resource extraction and the amount of resource extraction (a volume effect). Thus, carbon taxes do not cause a green paradox in this situation, but can be part of an effective green tax reform. Governments may not take climate externalities into account, as modeled in our paper. In that case, timing and volume effects per se do not affect decisions about fiscal policy. Nevertheless, these observed effects show that a unilateral tax reform which introduces a carbon tax also has beneficial environmental implications.

Our contribution is thus twofold. First, we bridge the gap between horizontal fiscal federalism, in particular the tax competition literature on the one hand, and the economics of exhaustible resources on the other. Using a numerical general equilibrium model we compute optimal tax portfolios and precisely assess their opportunity costs. To our knowledge, our model is the first to combine the following key features. We implement a decentralized market economy with several representative agents and strategically interacting governments. The tax instruments, which governments use to finance productive infrastructure stocks, are determined endogenously for both cooperative and non-cooperative behavior in the Nash equilibrium. Capital and fossil resources are traded on international markets and, we work with the dynamics of capital accumulation and resource extraction (based on the respective models of Frank P. Ramsey and Harold Hotelling). Second, we shed light on the supply side dynamics of fossil resource extraction. So far, most of the research on the conditions under which a green paradox occurs has used partial equilibrium analysis. Only recently has this strand of literature been extended to general equilibrium. Now, we take even one step further. Our model allows strategic interactions between fossil fuel selling and buying countries, as well as among the governments of buying countries themselves. We conclude that even when governments do not intend to address climate change, they still have an incentive to implement a carbon tax to improve their fiscal policy. Then, the carbon tax nevertheless helps mitigating the adverse effects of climate change. It is thus not only the environmental ministers who should favor carbon taxes, but also the ministers of finance.

Climate change and adaptation. A new opportunity for public debt relief?
E. Delpiazzo (1); C. Carraro (2); F. Bosello (3)
(1) CMCC, Venice, Italy; (2) FEEM, Climate change and sustainable development, Milan, Italy; (3) University of Milan, FEEM, and CMCC, Dep. of economics, Milan, Italy

Notwithstanding a consolidated and vast literature on the possibility to conjugate development and environmental protection, a view still rooted in the policy domains considers the environment identified as good less important than social goals like growth or employment. This is epitomized by the climate change challenge. On the one hand the trade-off development/ GHG mitigation is at the heart of the difficulty to involve developed countries in an international agreement on emission reduction. On the other hand, especially in a background of a financial crisis along with high levels of indebtedness and aging populations, high unemployment levels and the need for fiscal outlays for unemployment compensation or welfare benefits, climate change policies seem to appear as something which would not be regarded as an urgent policy also in many European countries. In fact, in a situation where public budgets are overstretched due to economic crisis, there is an increasing need to understand the implications of climate change impacts, climate change mitigation and adaptation policies on the fiscal side.

This is particularly true for those countries which experienced growing levels of deficit and debt in the last decades, and especially in those countries which experienced growing levels of deficit and debt in the last decades, and especially in those countries which are facing adverse effects of climate change. It is thus not only the environmental ministers who should favor carbon taxes, but also the ministers of finance.

Why finance ministers might favor carbon taxes, even if they do not believe in climate change
O. Edelhofer (1); M. Franks, (2); K. Lessmann (3)
(1) Potsdam Institute for Climate Impact Research, Potsdam, Germany; (2) Potsdam Institute for Climate Impact Research (PIK), Potsdam, Germany; (3) Potsdam Institute for Climate Impact Research, Sustainable solutions, Potsdam, Germany

The economic forces of globalization constrain democratic governments increasingly. According to Dani Rodrik, we cannot have democracy, national sovereignty and hyperglobalization at the same time (Rodrik, 2011)[1]. Hyperglobalization impinges on democratic choices within sovereign nations by giving rise to corporate tax competition, which "restricts a nation's ability to choose the tax structure that best reflects its needs and preferences" (ibid., p. 193). Declining corporate tax rates, complemented by a rising share of labor taxes, give evidence of the resulting race-to-the-bottom. The fact that this race-to-the-bottom impedes a government’s ability to raise sufficient funds has far reaching consequences. Funds are required, e.g., not only for health care or education, but also for productive public infrastructure, which is important for both efficiency and equity. Accordingly, an emerging consensus in the empirical literature suggests that these stocks are underfinanced. This raises the question how to reduce exposure to tax competition and generate funds to finance essential public goods.

We identify taxes on the use of carbon resources as a superior alternative to capital taxes. Even though fossil resources are also traded internationally, there is an asymmetry in efficiency between capital and resources as tax base. While ownership of fossil resources gives rise to a rent, capital does not. Taxes on either factor cause an intertemporal reallocation by driving economic behavior out of countries with relatively high tax rates. The carbon tax has the advantage, though, of capturing part of the resource rent. Governments can use the appropriated rent for productivity enhancing infrastructure investments, which in turn attracts investments in domestic capital stocks.

Further, it turns out that a carbon tax may not only have fiscal benefits. When the motivation to tax the use of fossil resources is based exclusively on fiscal needs, then resource exporters react by reducing both the rate of fossil resource extraction and the amount of resource extraction (a volume effect). Thus, carbon taxes do not cause a green paradox in this situation, but can be part of an effective green tax reform. Governments may not take climate externalities into account, as modeled in our paper. In that case, timing and volume effects per se do not affect decisions about fiscal policy. Nevertheless, these observed effects show that a unilateral tax reform which introduces a carbon tax also has beneficial environmental implications.

Our contribution is thus twofold. First, we bridge the gap between horizontal fiscal federalism, in particular the tax competition literature on the one hand, and the economics of exhaustible resources on the other. Using a numerical general equilibrium model we compute optimal tax portfolios and precisely assess their opportunity costs. To our knowledge, our model is the first to combine the following key features. We implement a decentralized market economy with several representative agents and strategically interacting governments. The tax instruments, which governments use to finance productive infrastructure stocks, are determined endogenously for both cooperative and non-cooperative behavior in the Nash equilibrium. Capital and fossil resources are traded on international markets and, we work with the dynamics of capital accumulation and resource extraction (based on the respective models of Frank P. Ramsey and Harold Hotelling). Second, we shed light on the supply side dynamics of fossil resource extraction. So far, most of the research on the conditions under which a green paradox occurs has used partial equilibrium analysis. Only recently has this strand of literature been extended to general equilibrium. Now, we take even one step further. Our model allows strategic interactions between fossil fuel selling and buying countries, as well as among the governments of buying countries themselves. We conclude that even when governments do not intend to address climate change, they still have an incentive to implement a carbon tax to improve their fiscal policy. Then, the carbon tax nevertheless helps mitigating the adverse effects of climate change. It is thus not only the environmental ministers who should favor carbon taxes, but also the ministers of finance.
More specifically, firstly, we assess the "direct" or "first round" effects of climate change on the public budget through changes in total tax revenues induced by impacts on production patterns and trade structure. This also originates indirect fiscal costs (or second round effects) as it impacts governments' fiscal capacity.

Then, we introduce the possibility of adaptation expenditures to reduce the climate change impacts. We explore adaptation long-run effects on fiscal capacity and fiscal flexibility under different assumptions of financing. Could there be room for issuing more debt (adaptation bonds) to cover climate adaptation expenditure inducing anyway in the long term a decrease in the debt/GDP ratio? Exploring adaptation effects on avoided future damages? Even though possible, would it be more efficient and cost-effective to support adaptation expenditure with revenues from other, e.g. carbon-energy, taxes? What are the different crowding out effects on public/private investment?

It can be established, that climate change has introduced a new aspect into the structure of public finances both in expenditure and in revenue side. In the context of the current multi-year crisis, public finances in the EU are strained, and thus the fiscal consequences of climate change are important to estimate and, the worst case scenarios need to be avoided. From few case studies in literature, it is evident that the fiscal consequences are not negligible. However, there has not yet been any study that consistently addresses how climate change and adaptation affect the state budget, and particularly its stability, in a general equilibrium framework.

K-4405-03

Complexity and Green Growth: A Practical Perspective
S. Van Der Leeuw (1)
(1) Arizona State University, Tempe, Arizona, United States of America

Practical policy aiming to seize macroeconomic opportunities for climate policy has to deal with complex interactions between macro-variables and the many processes that may or may not lead to such opportunities. The Global Institute of Sustainability at Arizona University is presently involved in a Chinese initiative to implement a green growth strategy in a poor rural region where these interactions can be investigated in real time.

The initiative is based on the seminal report «China 2030» produced by the Development Research Council (DRC), the think-tank of the Chinese prime minister, together with the World Bank. This report outlined the new growth strategy adopted by the Chinese leadership in 2013. The key macroeconomic variables relevant for the initiative are straightforward: GDP, employment, etc. The policy variables, however, are much more complex than typical discussions about simple variables like carbon prices, government deficits and the like suggest.

The initiative started by outlining a shared vision in an intense dialogue between the provincial government, DRC and international partners like Arizona State University and the Global Climate Forum. This on-going dialogue involves a wide variety of local actors. An instructive example is the work on a large company for electric bicycles who established a green theme park in the region in question. A key instrument to launch this dialogue was a transcontinental conference on green growth connecting actors across national boundaries. Therefore, effective crisis responses require an ability of present societies to process the complex information flows generated at the interface between society and environment.

In particular, this means to increase the division of labor by reducing transaction costs, in line with the insights of Adam Smith, Xiaokai Yang and others.

• it also means to embed climate policy in a comprehensive vision of green growth

• a competition for successful models of green growth is a promising way towards a transition to global green growth.

K-4405-04

Modelling the macroeconomic opportunity of climate policy
S. Wolf (1), F. Schuetze, (1); C. Jaeger (1)
(1) Global Climate Forum, Berlin, Germany

Economic policy analysis modelling has largely depicted climate change mitigation as a drag on economic development. In contrast, concepts as green growth, green economy and results of recent studies, such as the New Climate Economy Report, suggest that reducing emissions need not slow down but may benefit the economy.

The possibility of protecting climate while enhancing economic development deserves to be carefully researched. Economic models constitute an important tool for doing so. Unfortunately, this possibility is beyond the horizon of the marginal analysis conducted with many conventional climate policy analysis models. Rooted in the general equilibrium framework, these models mostly find economic costs of mitigation when optimizing in the vicinity of a «business as usual» equilibrium.

A survey of models that can represent economic benefits from climate change mitigation reveals a large spectrum of approaches for going beyond this standard modelling setup. At the more conventional end of the spectrum, the literature provides theoretical model extensions, for example to address external effects, that open up the possibility of positive economic effects from climate policy. Computational models further away from the general equilibrium and optimization approach, such as system dynamics models or a macroeconomic model for climate policy analysis, can be viewed as the other end of the spectrum. Within the general equilibrium framework, but outside common modelling practice, several studies conceptualize the current fossil-fuel based economy and a low carbon economy as different equilibria of the economic system. For example, inframarginal economics generalizes the marginal analysis approach by considering different structures of specialization and division of labour. By modelling structural change to the division of labour that is triggered by mitigation policy, the possibility of green growth can be represented and analysed. Similarly, an analysis of a virtuous circle of expectations, investment and learning-by-doing has shown that investment oriented climate policy can induce a shift to a new growth path with lower emissions but higher growth and employment.

This contribution focuses on the question how climate policy can facilitate a recoordination of investors' expectations so as to induce a transition to a green growth equilibrium and how this can be modelled.

O-4405-01

Overview of climate finance at scale
T.E. Downing (1)
Managing Climate Change Risks and Vulnerabilities: A Microfinance and Climate Finance Perspective

D. Chirambo (1)

(1) Seeds of Opportunity, Blantyre, Malawi

Climate change touches upon a myriad of inter-related and multi-dimensional aspects of societies, economies and the environment. From an African perspective, climate change may be considered as a phenomenon that may seriously hamper the continent’s future development and pose as an additional impediment to sustainable development. Since climate change impacts are anticipated to vary across countries and localities with some geographic regions being anticipated to suffer more from climate change than others, the divide existing in national capacities, it can be argued that the poorest and most vulnerable groups and countries will likely be the most affected, consequently increasing world inequality.

Even though different countries have various models and approaches for climate change risk assessments and management, it is widely believed that in order to reduce the impacts of climate change on various countries, and to ensure that international consensus and policies for climate change mitigation, adaptation and financing can be achieved, the post-Kyoto development agendas should increase funding towards climate change initiatives most notably in developing countries and promote mechanisms for raising the capacity for effective climate change management. Least Developed Countries (LDCs), including focusing on women, youth and local and marginalised communities.

To date, most climate financing modalities and projects in Africa have had limited or no effect in terms of poverty alleviation and sustainable development due to a lack of emphasis on strengthening the participation of marginalised groups, and the continent’s adaptation deficit as caused by a lack of institutional, financial or technological capacity to adapt effectively to climate change. In addition to this, even though climate financing for development and adaptation should be anticipated will receive the same priority, research has shown that the implementation of climate finance modalities are highly constrained towards mitigation efforts whereas 91% of climate finance flows are for adaptation efforts, 7% for adaptation efforts and 2% for activities with both mitigation and adaptation objectives. Cumulatively, these issues suggest that most communities in Africa could be becoming more vulnerable to the impacts of climate change.

Recent research shows that almost three-quarters of climate finance flows are invested with the expectation of earning commercial returns, hence signifying the need for innovative climate financing models that provide win-win situations for funders and recipients, as well as the world at large as the risks and consequences attributed to climate change can be minimised. In order to determine the opportunities that exist in enhancing the capacities and opportunities for microfinance for climate change mitigation and adaptation initiatives, and disaster risks and management, this paper expounds the Microfinance–Climate Finance Framework that was shortlisted for the 2014/2015 UNDP MDG Carbon Climate Finance Innovation Award. Using this framework, it is possible to highlight the challenges and opportunities that microfinance institutions could have in the mobilisation of funds and resources from various types of funders, and redistribution of funds and resources to various types of recipients. This paper concludes that fostering international and domestic policies that encourage remittances and financial inclusion may be an effective strategy to encourage microfinance based climate change management funding.

Relative price adjustment of energy and labour: The case of energy-dependent and small open economies

E. Combet (1)

(1) Centre International de Recherche sur l’Environnement et le Développement (CIRED), Nogent-sur-Marne, France

The increase in energy prices is the cornerstone for policies that seek to manage efficiently energy systems in the long run (including climate policies). However, such a price increase may harm the economy during the transition, when substitutions have not yet taken place. In this paper, we consider an increase in the relative price of energy with respect to labour, and we analyse its consequences for aggregate domestic production and employment. We develop a general equilibrium model of small, open-economy assuming unemployment and high dependence to imported energy. Simplified enough to be solved analytically, this model does not restrict the analysis to the neighbourhood of an optimum. We examine how the quantitative result – a net positive or negative impact on production and employment – is sensitive to a set of debated parameters on 1) the behaviour of the economy (the reactions of domestic wage and the response of external trade), 2) the initial state of the economy (the levels of energy consumptions, unemployment and wages), 3) the import price of fossil energy, and 4) the relative initial taxation of energy and labour.

Carbon Tax, Pensions and Deficits

E. Combet (1)

(1) Centre International de Recherche sur l’Environnement et le Développement (CIRED), Nogent-sur-Marne, France

This paper aims to draw attention on the consequences of the prevailing intellectual compartmentalization between ‘energy and climate’, on the one hand, and ‘the viability of social security systems’, on the other. We take the methodological venture of building a general equilibrium model to analyse jointly these issues. The model is applied to France and projected to a future horizon (2050). It ensures consistency by linking together 1) a description of the future constraints on energy and demand, and 2) a partial forecasting scenario of the pension system. First, we analyse two types of archetypical reforms that use one instrument to meet one objective. The first type recourses to one of the present elements of the pension system (social security contributions on wage income, age of retirement). The second type absorbs the deficits of the pension system by preempting revenues generated by the climate policy (here a carbon tax). After examining the limitations of those single-instrument/single-objective policies, we provide an example of a multi–objective policy package that enables the limitations to be removed. In so doing, we present a way of exploring potential synergies between long term development goals.
Today's financial markets are characterized by globalization and interdependence, while nations around the world are still suffering from the economic and social aftershocks of the global financial crisis. Politicians, economists, NGOs and concerned citizens have scrutinized the weaknesses of the current financial system. A consensus is emerging that the current financial and economic structures are not sustainable and the danger of another socioeconomic crisis persists in spite of a plethora of regulatory changes. A grassroots movement for sustainable development is leveraging investments as a tool to achieve social and ecological benefits while promoting fundamental structural changes in the finance industry and in public finances. A variety of innovative investment strategies including ethical, “green”, “social”, “responsible” investments as well as social banking and sustainable investing combine social, ethical and/or ecological objectives with financial returns, distinguishing them from so-called mainstream investments pursuing only risk-adjusted returns. At the same time, many large financial institutions have jumped on the “sustainable investment bandwagon”, trying to profit from the rapidly growing demand for sustainable investment products by “greenwashing” conventional investment products, which do not offer any sustainability benefits. Contradictory marketing claims confuse potential investors and prevent the successful mainstreaming of genuine sustainable investment products. False marketing claims lead to consumer cynicism and growing mistrust towards the financial services industry. We draw upon a case study of “Impact Investments” to explore this issue. We are going to utilize analogous cases in different industries to draw lessons for marketing and certification strategies for Impact Investments. In view of the insights from diverse economic sectors, e.g., the chocolate, forestry and fishery industries, we observe that certification systems are an efficient mechanism to foster principles of sustainable development within a globalized market economy (i.e. Fair Trade, Forest Stewardship Council, Marine Stewardship Council). We further identify the current certification schemes existing in the financial sector and discuss their repercussions, also considering ongoing projects that seek to tailor accounting guidance to different actors of the financial system. Based on the insights taken from these case studies, we plead in favour of the idea that a standardized international certification would help to restore trust in financial services and help to mainstream impact investing (getting it out of the “green niche”). Certification could help impact investments gain the necessary «critical market share», and ultimately, intentionality to consume impact investment products.

**P-4405-04**

**Impact of community own revolving fund in adapting with changing climate in Nepal**

S. Paudel (1)

(1) The Small Earth Nepal, Kathmandu, Nepal

By now the scientific community agrees that climate change is occurring and its impacts are more in the developing countries. Nepal is experiencing significant changes in climate, which have a direct and severe impact on the livelihood of its people, most of whom are still rural. A study has been undertaken to look at the impact of a community own revolving fund - a concept of micro-financing in adapting the changing climate in Nepal. The farmers in three agro-ecological zones of Nepal have been provided with the bucket drip irrigation set for their kitchen gardening, the system which is highly water efficient and less time consuming. The farmers are being charged NPR 100 (~USD 1) per set and the money is collected as a source of revolving fund. The money has now been given to the needful member of the cooperative which needs to be invested only in vegetable cultivation sector which gives quicker income. After six months, the amount is offered to the second needy persons and so on. In this particular paper, we describe the fund circulation mechanisms, community engagement on the project and its benefits in short and long run.

**4406a - Climate, Sustainable Development and Energy Security**

**ORAL PRESENTATIONS**

**K-4406a-01**

**Energy and Climate Challenges: The case of India**

P. Shukla

Abstract not communicated

**K-4406a-02**

**Energy and Development in Emerging Countries: Examples drawn from China**

J. Reilly

Abstract not communicated

**O-4406a-01**

**Nexus of climate mitigation and key developmental objectives - An analysis for South Africa**

J. Schers (1); F. Lecocq (2); F. Ghersi (2)

(1) CIRED, Nogent sur Marne, France; (2) Centre International de Recherche sur l’Environnement et le Développement, Nogent sur Marne, France

South Africa is a rapidly growing middle-income economy with a coal-based energy system that generates high greenhouse gas emissions, on par with the richest economies in the World. The country has pledged to significantly reduce its emissions (by 34% in 2020 and by 42% in 2025 relative to business-as-usual, under the condition of finance and technical support from the international community). It is actively discussing policies to achieve this goal, including a carbon tax.

Yet, climate mitigation is not the only challenge that South Africa faces. Despite significant progress in overcoming the inequalities inherited from the Apartheid era and in improving quality of life since the onset of the democratic regime in 1994, the economic growth has slowed down in recent years, poverty remains high and large inequalities persist. In particular, the South African economy is still experiencing very high unemployment, in particular amongst low-skill individuals, while there is shortage of high-skill workers.

The present paper aims to provide some insights on the nexus between South Africa’s mitigation objectives and the key development challenges outlined above. It focuses in particular on economic growth and unemployment, in the context of inequality and education. For this purpose we developed IMACLIM-SA a dynamic, computable general equilibrium of the South African economy. IMACLIM-SA represents the South African economy as a small, open economy with ten sectors (five energy, five non-energy) and five household classes. Calibrated on 2005 data, the model produces an equilibrium of the economy in 2035 based on assumptions about change in key parameters.

Particular attention is paid to the input data, with the production of a revised social accounting matrix to match monetary flows drawn from macroeconomic statistics and energy flows drawn from energy tables. The model captures differences in the prices of goods and services (notably energy) between firms, households, the public sector and exports. We use outcomes of runs of the SA TIMES model of the Energy Research Center of the University of Cape Town to inform changes in electricity production in IMACLIM-SA. Particular attention is given to the labour market, in terms of supply—with three skill classes—and demand, in production and market functioning and imperfections.

In the reference scenario, given our assumptions, GDP grows at an average rate of 3.4% per year, and GDP per capita more than doubles over the period. It must be noted
that to generate such level of growth in the baseline, we must assume not only capital and labour productivity improvements, but also an increase in international prices relative to domestic ones, thus improving competitiveness of South African products on the export market. Unemployment decreases markedly, though it remains important in 2035, and shortage of high-skill labour persists. In the reference projection, emissions increase substantially, despite implementation of the Updated Integrated Resource Plan of 2013.

We then explore seven policy packages based on the imposition a carbon tax of 100 Rand (ZAR 2005) per tonne of CO2 with different recycling schemes. We find that CO2 emissions in South Africa are sensitive to even a relatively “small” carbon tax by international standards, though it is high relative to 2005 domestic prices of energy. A 100 Rands per ton CO2 tax is not sufficient to meet the government’s “IDEAL scenario”, we consider emissions cuts of 40% in 2030 50% in 2050 as compared with the baseline and the 2000 levels, respectively. This requires carbon tax to reach US$ 100 in 2030 and US$ 867 in 2050. We take the case with no tax compensation for the first. Because of substitution effects in energy-intensive production inputs and consumption goods, the policy is successful in reducing CO2 emissions by more than 80% by 2050 with respect to BAU. But the environmental goal is achieved at very high economic costs, with GDP dropping by more than 10% after 2040.

Then we test the hypothesis of full redistribution of carbon tax revenues among consumers (through reducing household income taxes and providing lump-sum transfers to households), as well as at lower levels of redistribution. The former results in higher consumer spending, that is consistent with prior literature on redistribution effects, though it is high relative to 2005 domestic prices of energy. A 100 Rands per ton CO2 tax is not sufficient to meet the government’s “IDEAL scenario”, we consider emissions cuts of 40% in 2030 50% in 2050 as compared with the baseline and the 2000 levels, respectively. This requires carbon tax to reach US$ 100 in 2030 and US$ 867 in 2050. We take the case with no tax compensation for the first. Because of substitution effects in energy-intensive production inputs and consumption goods, the policy is successful in reducing CO2 emissions by more than 80% by 2050 with respect to BAU. But the environmental goal is achieved at very high economic costs, with GDP dropping by more than 10% after 2040.

Then we test the hypothesis of full redistribution of carbon tax revenues among consumers (through reducing household income taxes and providing lump-sum transfers to households), as well as at lower levels of redistribution. The former results in higher consumer spending, that is consistent with prior literature on redistribution effects, though it is high relative to 2005 domestic prices of energy. A 100 Rands per ton CO2 tax is not sufficient to meet the government’s “IDEAL scenario”, we consider emissions cuts of 40% in 2030 50% in 2050 as compared with the baseline and the 2000 levels, respectively. This requires carbon tax to reach US$ 100 in 2030 and US$ 867 in 2050. We take the case with no tax compensation for the first. Because of substitution effects in energy-intensive production inputs and consumption goods, the policy is successful in reducing CO2 emissions by more than 80% by 2050 with respect to BAU. But the environmental goal is achieved at very high economic costs, with GDP dropping by more than 10% after 2040.

Then we test the hypothesis of full redistribution of carbon tax revenues among consumers (through reducing household income taxes and providing lump-sum transfers to households), as well as at lower levels of redistribution. The former results in higher consumer spending, that is consistent with prior literature on redistribution effects, though it is high relative to 2005 domestic prices of energy. A 100 Rands per ton CO2 tax is not sufficient to meet the government’s “IDEAL scenario”, we consider emissions cuts of 40% in 2030 50% in 2050 as compared with the baseline and the 2000 levels, respectively. This requires carbon tax to reach US$ 100 in 2030 and US$ 867 in 2050. We take the case with no tax compensation for the first. Because of substitution effects in energy-intensive production inputs and consumption goods, the policy is successful in reducing CO2 emissions by more than 80% by 2050 with respect to BAU. But the environmental goal is achieved at very high economic costs, with GDP dropping by more than 10% after 2040.

The vast majority of scenarios assessed in the IPCC’s AR5 focus attention on mitigating greenhouse gas emissions. Several studies have examined the interaction between policies to promote fossil-based modern energy access for cooking and climate mitigation policies. The distributional outcomes depend on existing subsidy policies, patterns of income growth, and the types of climate policies. This paper presents a rigorous assessment of these issues using the MESSAGE-Access model, a household

This paper is the result of a two–year research collaboration involving the National Institute of Ecology and Climate Change (INECC), the French Economic Observatory (OFCE) and the French Agency for Development (AFD).

A conceptual framework for the quantification of co-benefits

D. Urge Vorsatz

Abstract not communicated

The Interaction of Climate Mitigation and Universal Energy Access Policies

S. Pachauri (1); N. Rao (2); K. Riahi (3)

(1) International Institute for Applied Systems Analysis, Laxenburg, Austria; (2) IIASA, Energy, Laxenburg, Austria; (3) International Institute for Applied Systems Analysis, Energy Program, Laxenburg, Lower Austria, Austria

The vast majority of scenarios assessed in the IPCC’s AR5 focus attention on mitigating greenhouse gas emissions. Several studies have examined the interaction between policies to promote fossil-based modern energy access for cooking and climate mitigation policies. The distributional outcomes depend on existing subsidy policies, patterns of income growth, and the types of climate policies. This paper presents a rigorous assessment of these issues using the MESSAGE-Access model, a household

This paper is the result of a two–year research collaboration involving the National Institute of Ecology and Climate Change (INECC), the French Economic Observatory (OFCE) and the French Agency for Development (AFD).

O-4406a-02

A Dynamic General Equilibrium Assessment of the Energy-Climate-Development Link in Mexico

F. Grazi (1); G. Landa (2); FX. Bellocq (3); F. Reynès (4); I. Islas Cortes (5)

(1) Agence Française de Développement (AFD), Research Department, Paris, France; (2) OFCE, Paris, France; (3) Agence Française de Développement (AFD), Paris, France; (4) TNO, Delft, Netherlands; (5) National Institute of Ecology and Climate Change, Directorate for sectoral policy, Mexico City, Mexico

This paper offers an empirical application of the notion of energy transition to the Mexican economy and takes the next step of simulating medium– and long-term impacts of energy policy on the environment and the Mexican economy. The starting point of the analysis comes from ThreeMe framework, a Multi–sectoral Macroeconomic Model for the Evaluation of Environmental and Energy policy, which is motivated by neo–Keynesian theory. It is designed to address dynamics of global economic activity, energy system development and carbon emissions causing climate change. The ThreeMe model is well suited for policy assessment purposes in the context of developing economies as it informs the transitional effects of policy intervention. In particular, disequilibrium can arise in input–output framework of technical systems and rigidity of labor and energy markets, as a result of delayed market-clearing in the goods markets and slow adjustment between prices and quantities over the simulation time path.

Calibrated to updated aggregate and sectoral national accounts data, a Mexican version of the ThreeMe is developed that accounts for 24 commodities–including 3 energy sources–and 32 sectors, with an explicit distinction between 11 energy sectors and 7 transport sectors. Electricity production is disaggregated into 9 technologies: hydro, gas, oil, wind, solar, biomass, nuclear, coal–based, oil–based and gas–based. The ThreeMe–Mexico model is used to gauge the economic and environmental effects of energy fiscal policy measures in Mexico (mainly promoting subsides and withdrawal of subsidies for the implementation of a carbon tax). Different policy scenarios are assessed, each reflecting a different strategy of fiscal revenue recycling. We consider fiscal policy for energy transition in Mexico in the type of Carbon tax and simulate the effects on Mexico’s economy and carbon emissions of alternative government’s patterns of transferring tax revenues. The level of the carbon tax is endogenously computed to meet national emissions reduction targets, as stated in the Mexican “Climate Change Law”. In line with government’s “IDEAL scenario”, we consider emissions cuts of 40% in 2030 50% in 2050 as compared with the baseline and the 2000 levels, respectively. This requires carbon tax to reach US$ 100 in 2030 and US$ 867 in 2050. We take the case with no tax compensation for the first. Because of substitution effects in energy-intensive production inputs and consumption goods, the policy is successful in reducing CO2 emissions by more than 80% by 2050 with respect to BAU. But the environmental goal is achieved at very high economic costs, with GDP dropping by more than 10% after 2040.

This paper is the result of a two–year research collaboration involving the National Institute of Ecology and Climate Change (INECC), the French Economic Observatory (OFCE) and the French Agency for Development (AFD).

O-4406a-03

A conceptual framework for the quantification of co-benefits

D. Urge Vorsatz

Abstract not communicated

O-4406a-04

The Interaction of Climate Mitigation and Universal Energy Access Policies

S. Pachauri (1); N. Rao (2); K. Riahi (3)

(1) International Institute for Applied Systems Analysis, Laxenburg, Austria; (2) IIASA, Energy, Laxenburg, Austria; (3) International Institute for Applied Systems Analysis, Energy Program, Laxenburg, Lower Austria, Austria

The vast majority of scenarios assessed in the IPCC’s AR5 focus attention on mitigating greenhouse gas emissions. Several studies have examined the interaction between policies to promote fossil-based modern energy access for cooking and climate mitigation policies. The distributional outcomes depend on existing subsidy policies, patterns of income growth, and the types of climate policies. This paper presents a rigorous assessment of these issues using the MESSAGE-Access model, a household
Climate change and poverty

S. Hallegatte (1)
(1) Climate Change Group, Washington, United States of America

Climate change and climate policies will affect poverty reduction efforts through direct and indirect impacts on the poor and by affecting factors that condition poverty reduction, such as economic growth. This presentation will summarize a research program conducted at the World Bank with many external partners to explore this relation between climate change and policies and poverty outcomes by examining three questions: the (static) impact on poor people’s livelihood and well-being; the impact on the risk for the non-poor individuals to fall into poverty, and the impact on the ability of poor people to escape poverty. The presentation proposes four key factors that determine household consumption and through which households may escape or fall into poverty (prices, assets, productivity, and opportunities). It then discusses whether and how these channels are affected by climate change and climate policies, focusing on the exposure, vulnerability, and ability to adapt of the poor (and those vulnerable to poverty). It reviews the existing literature and offers three major conclusions. First, climate change is likely to represent a major obstacle to a sustainable eradication of poverty. Second, climate policies can benefit the poor provided that (i) poverty concerns are carefully taken into account in their design and (ii) they are accompanied by the appropriate set of social policies. Third, climate change does not modify how poverty policies should be designed, but it creates greater needs and more urgency. The scale issue is explained by the fact that climate will cause more frequent and more severe shocks; the urgency, by the need to exploit the window of opportunity given to us before climate impacts substantially increase.

Planetary Boundaries: Abundance within a Global Carbon Budget

J. Rockström (1)
(1) Stockholm Resilience Center, Stockholm university, Stockholm, Sweden

Planetary Boundaries: Abundance within a Global Carbon Budget

Extraordinary climate stability since the end of the Holocene 11,000 years ago, has provided the necessary conditions for human development. Human activity is now pushing the Earth system towards the limits of its ability to support further unsustainable development, in many cases, with inescapable consequences to the survival of the poorest and most vulnerable societies. These planetary boundaries describe the human influence on and limits to Earth life support systems. Within the current paradigm of development, we have already crossed planetary boundaries associated with carbon dioxide levels driving climate change, the loss of biodiversity, the addition of phosphorus, nitrogen and other nutrients to ecosystems, and deforestation. The latest research shows that in some cases these changes may be irreversible, having crossed a tipping point.

A new framework of sustainable development is required to ensure that humanity remains within the ‘safe operating space’ of the planet defined by the planetary boundaries, whilst allowing all societies to become more prosperous on a resilient planet. 2015 offers a unique opportunity to address key aspects of this existential challenge. Negotiations on the new Global Climate Agreement in December and discussions on the UN Sustainable Development Goals in September, are important fora for charting a holistic path to an equitable and safe future for all societies. The risk of crossing additional planetary boundaries will rise with delayed action on both these fronts, driving the Earth system further away from the stable conditions that have supported human development until now. In particular, a global climate change agreement that limits warming to well below 2 degrees and respects key equity principles is necessary to enable achievement of development objectives.

This contribution draws on recent new research on Planetary Boundaries and on the Earth Statement project led by the Earth League.

Feasible Mitigation Options for Developing Countries

J. Steckel (1) ; M. Jakob (2) ; N. Rao (3)
(1) Mercator Research Institute for Global Commons and Climate Change, Climate and Development, Berlin, Germany; (2) Mercator Research Institute for Global Commons and Climate Change, Berlin, Germany; (3) IIASA, Energy, Laxenburg, Austria

This talk will emphasize challenges and possibilities for climate change mitigation in the context of sustainable development imperatives. Mitigating global climate change will require large scale reductions of GHG emissions not only in industrialized, but also in developing countries. However, historically, economic and social development has been highly correlated with fossil fuel use. In the recent past, economic growth in China, which has lifted hundreds of millions people out of poverty, has gone hand in hand with a dramatic carbonization of the Chinese energy system. As other newly industrializing countries are currently following the same track there is a risk of creating a lock-in of carbon-intensive energy infrastructures which will render ambitious climate stabilization targets difficult to achieve.

Even though the recent surge in coal has been accompanied by a market-driven proliferation of renewables in emerging economies such as India and China, the question arises how, and to what extent, the pursuit of economic growth and poverty alleviation can avoid the repetition of historical carbon-intensive development patterns.

While mitigation costs are expected to be moderate on the global scale, they still can – depending on the burden sharing scheme in place – pose serious challenges for financially and institutionally constrained developing countries. For these countries, other considerations, such as poverty alleviation, are likely to constitute more pressing short-term policy objectives. Even with financial support from the global community, there are serious concerns regarding the potential negative effects of financial inflows e.g. on the development of advanced industries.
Various approaches have been proposed to support developing countries in formulating national climate policies, including financial assistance of USD 100 bn per year from the Green Climate Fund. Such transfers can only be effective if they are designed in a way that minimizes political and social effects by means of transparency mechanisms, monitoring and conditionality. They also need to guarantee ownership by recipients by embodying a broad perspective on climate change that takes into account countries' specific development objectives. In this regard, recent research has highlighted that policies that do not only aim at reducing emissions, but also leverage substantial co-benefits are most likely to be politically feasible. Prominent examples of such “win-win policies” include clean-air policies, reforming fossil fuel subsidies, and improving public transport systems, as well as improved agricultural practices and inclusion of climate change considerations in regional trade agreements.

As a consequence, these policies have the potential to overcome the “dangerous climate change vs. dangerous mitigation” dilemma. By defining appropriate guardrails for natural as well as social objectives, they incorporate a multi-dimensional perspective of sustainable development. Such sustainable development objectives could further advance bottom-up incentives for individual countries to embark on a climate-friendly development pathway. In this paper, we pinpoint an entry point for more ambitious climate policies, including an internationally binding agreement – in the future.

**O-4406b-01**

### Human development in a climate-constrained world: what the past says about the future

W. Lamb (1) ; N. Rao (2)

(1) Tyndall Centre for Climate Change Research, School of Mechanical, Aerospace and Civil Engineering, University of Manchester, Manchester, United Kingdom; (2) IIASA, Energy, Laxenburg, Austria

Energy consumption is necessary for the delivery of human development by supporting access to basic needs, services and infrastructures. Given prevailing technologies and the high degree of inertia in practical rates of decarbonisation, raising global living standards may entail growth in energy consumption and consequent greenhouse gas emissions (GHG) impact on the climate system. Yet despite considerable elaboration in the literature on equity proposals and implications of emissions rights between industrial and developing nations, there is very little research on the actual energy use necessary for development and likely arising emissions. This is a pressing issue as the context of on-going international negotiations, where it is now recognized that the participation of all major emitters, including key developing countries, is required to break the climate impasse. Our question thus focuses on extrapolating existing trends in energy growth, emissions and human development progress; highlighting the level of policy ambition that will be necessary to meet the twin challenges of climate change and poverty alleviation.

We build on recent work analysing the interaction between human development and energy use [1,2] and base our presentation on a forthcoming publication in Global Environmental Change [4]. Yearly cross-section regressions on 3 pairs of country development and energy consumption data for the period 1990–2010: life expectancy, access to basic needs and GDP per capita as dependent variables; per capita final energy consumption as an independent variable. Access to basic needs and indicators for six dimensions of the bare minimum requirements for development (access to sanitation, electricity, water, food supply, education and a survival rate). Following Steinberger et al. [3] we estimated hyperbolic saturation curves from this historical data, on the basis of which we project future energy for development as usual (DAU) to threshold levels of each human development indicator. We find an unbroken, near-continuous trend in human development improvement over the past two decades. We then explore the resulting space of possible futures, using several indicators of poverty and income distribution and use scenario discovery techniques to identify the main drivers of inequalities and poverty reduction. We find that in many countries, redistribution and structural change are powerful drivers of poverty and inequality reduction, except in low-income countries. In the poorest countries in particular, redistribution is not only necessary but also likely, while inequality can only be avoidable. Compared with the IAM scenario, a cost-based allocation of emissions rights also appears difficult to reconcile with poverty alleviation; while high levels of baseline needs and life expectancy can only be achieved through lower levels of emissions than continued economic growth.


**O-4406b-02**

### Projecting Household Surveys to Assess the Impact of Future Economic Conditions and Climate Change on the Poor

J. Rozenberg (1) ; S. Hallegatte (2)

(1) World Bank, Climate Change Group Chief Economist Office, Washington DC, United States of America; (2) Climate Change Group , Washington , United States of America

This paper quantifies the potential impacts of climate change on poverty in 2030 and 2050, in 92 countries covering 90% of the developing world population. It accounts for the deep economic “shocks” through future socio-economic evolutions. It also considers many impacts of climate change, based on original work commissioned by the World Bank.

To build scenarios, we use a micro-simulation model based on household surveys and explore a wide range of uncertainties on future structural change, productivity growth or demographic changes. This results, for each country, in the creation of several hundred scenarios for future income growth and income distribution. We then explore the resulting space of possible futures, using several indicators of poverty and income distribution and use scenario discovery techniques to identify the main drivers of inequalities and poverty reduction. We find that in many countries, redistribution and structural change are powerful drivers of poverty and inequality reduction, except in low-income countries. In the poorest countries in particular, redistribution is not only necessary but also likely, while inequality cannot rely on redistribution but requires low population growth and sustained productivity growth in agriculture.

Once we have explored the space of possible outcomes for poverty and inequalities in each country, we choose two representative scenarios of the best and worst cases and model the impacts of climate change in each of these two scenarios. Climate change impacts are not only driven by temperature but also by changes in precipitation patterns and the observed autonomous improvement in the efficiency of delivering human development, but assumes no near-term climate policy. In the final stage of our analysis, the DAU scenarios are translated into GHG emissions using intensities from an integrated assessment model (IAM) and the resulting pathways are compared to a cost-based allocation of emissions rights. This allows us to contrast likely development outcomes with a high-emissions scenario in which only economic efficiency is prioritised.

We find an unbroken, near-continuous trend in human development improvement over the past two decades. As in previous studies we find a high rate of decoupling between human development and energy consumption, but with regionally distinct patterns leading to diverging estimates of the total GHG emissions required for meeting development needs. Nonetheless, in the absence of policy, human development in these regions is likely to generate approximately 1000Gt CO2eq by 2050, a quantity unlikely to be compatible with internationally agreed goals to limit climate change to 2°C. The results are sensitive to the rate of decoupling and level of ambition in human development progress, with existing examples of more efficient pathways offering hope that such sustainability be avoided. Compared with the IAM scenario, a cost-based allocation of emissions rights also appears difficult to reconcile with poverty alleviation; while high levels of baseline needs and life expectancy can only be achieved through lower levels of emissions than continued economic growth.


are mostly concentrated in African and South-East Asian countries. For high radiative forcing (RCP8.5), the impact of climate change on poverty is 6 times larger in the pessimistic scenario than in the optimistic scenario, illustrating how development and poverty reduction are powerful adaptation tools. Our results stress the urgency of achieving poverty eradication by 2030 in order to limit the negative impacts of climate change on the poor.

**O-4406b-03**

**Climate resilient development: indicators and selection criteria for climate aid financing**

A. Miola (1)

(1) EU Joint Research Center Institute for Environment and Sustainability, Ispra, Italy

This work aims to contribute to the debate on climate change policies and their link to development. We adopted a climate resilient perspective to understand how climate change policies objective can be reconciled with development goals and to explore win-win opportunities given by the integration of the climate change and poverty reduction policies.

First, we review the main theoretical concepts that characterize scientific literature on climate risk and vulnerability assessments, and identify climate resilient indicators accordingly.

This made it possible to build the theoretical foundations for a new design index, design to improve our understanding of the implications of aid financing on reversing unsustainable paths, reducing vulnerability to climate change related hazards and get more equitable outcomes.

The novelty of our contribution lies on the emphasis given to economic aspects related to climate risk assessment, most notably: the concepts of loss and damage, the understanding of factors enhancing economic resilience, the links between climate change policies and development (climate change adaptation and growth) and the acknowledgment of the role of natural capital in pursuing development policies.

By reviewing grey and peer-reviewed literature, we identified 133 suitable indicators, which have been grouped along six components. These have been selected from a preliminary list of 300 indicators, on the basis of general criteria like validity, data availability and their value in terms of information potential. Other specific criteria have been considered, to ensure that the indicators shortlisted are theoretically robust.

**O-4406b-04**

**Historical analogies to forecast climate change induced fluctuations of Western Africa countries’ macroeconomic indicators**

F. Baarsch (1); M. Schaeffer (1); J. Granadillos (1); AS. Lüttringhaus (1); D. Coumou (2); B. Hare (1); M. Krapp (1); A. Robinson (3); R. Makhaza (1); R. Schwarze (4); M. Knaus (2)

(1) Climate Analytics, Berlin, Germany; (2) Potsdam Institute for Climate Research, Potsdam, Germany; (3) Universidad Complutense de Madrid, Madrid, Spain; (4) UFZ, Leipzig, Germany

Due to the increased impacts of climate-related extreme events, a rapidly growing literature has documented the relation between macroeconomic outputs, climate variability and human induced climate change. Methodologies for either proving or discrediting climate change can be divided into two categories: on statistical approaches showing that climate variability and future human induced climate change could have effects on gross domestic product (GDP). However, current statistical approaches mostly rely on linear econometric regressions with limited specifications of climate variables, while models have a limited evidence basis.

Using a statistical approach for its evidence basis, we investigate the relationships between macroeconomic variables (investment, trade balance, sectoral value added and GDP) and climate variables in Africa from the 1960s to the present. The approach is based on a nonlinear econometric model using a piecewise regression function adapted from Schlenker and Robert (2009). Time-lagged effects are also investigated. A large set of specifications of climate variability is assessed as regressors including among others: weighted anomaly standardized precipitation index, standardized Palmer drought severity index. For each “piece” of climate variability in Western Africa we infer climate analogy coefficients estimating the relation between climate variability and a climate-induced fluctuation of macroeconomic output.

Applying the inferred coefficients to projections from global and regional climate models, we estimate their effects on GDP and adjust African Development Bank’s forecasts for Western Africa.

This research project is supported by the United Nations Environment Programme (Regional Office for Africa), the African Development Bank and the United Nations Economic Commission for Africa.

**P-4406-01**

**Underlying causes of the growing adaptation deficit in the context of development**

I. Burton (1)

(1) University of Toronto & IPCC (ARS WGI Chap. 20), School of the Environment, Toronto, Ontario, Canada

Evidence is presented to show that climate change adaptation (CCA) and disaster risk reduction (DRR) are promoted and implemented with little or no reference to the development practices that are generating increased risk. The reverse is also true. Aggregate public and private investments made largely regardless of their contribution to increased exposure and vulnerability, exceed by orders of magnitude the present and projected expenditures on CCA and DRR. Reports on Inclusive Green Growth (World Bank 2012) and cumulative evidence on the changing pathways to impact (van der Berg and GEF 2013) provide information to show that the «cure to damage» ratio is in the order of 1:1,000. In the public sector, a current estimate of what funds are available annually to developing countries for adaptation ($1 billion) compares with $1 trillion as a conservative estimate of amounts of public funding available for harmful practices such as subsidies for fossil fuels, water practices that deplete resources, fisheries and agriculture (IMF).

A similar story applies to increasing losses from «natural» disasters that will be increasingly related to weather and climate. The dominant economic and investment paradigm of development accords little attention to the incidental effects, in increasing exposure and vulnerability. Thus the adaptation deficit (Burton 2004) continues to grow along with the disaster risk reduction deficit.

Development investments (especially in the private sector) that increase risk are being explained as «the cost of doing business», or simply as «externalities». This is reminiscent of the problem of acid precipitation and other pollution issues of a generation ago, where eventually transboundary and regional agreements were achieved through the recognition of «the polluter pays principle». If humanity is to move more effectively towards a common future there will have to be a similar recognition of the principle «the creators of disaster risk and the adaptation deficit pays». Without such transformation the adaptation deficit and the disaster risk deficit are likely to keep on growing with serious consequences for our common future.

**P-4406-02**

**Climate policy architecture for the Cancun’s paradigm shift: Building upon the lessons from history**

C. Cassen (1); JC. Hourcade (2); PR. Shukla (3)

(1) CIRED, PARIS, France; (2) International Research Center on Environment and Development (CIRED), Paris, France; (3) Indian Institute of Management, Ahmedabad, India

In the successions of Conferences of the Parties (COP) since Copenhagen, the Cancun conference (COP-16) marked a turning point at least on paper: it calls for “...a paradigm
Climate compatible development (CCD) is increasingly important to policy makers as a ‘triple-win’ strategy, combining climate adaptation and mitigation with development (Mitchell and Maxwell, 2010). CCD characterises a development pathway in that it is multi-sectoral and multi-scalar (Mitchell et al., 2014). What is less clear is if in bringing together climate adaptation and mitigation with development, CCD is creating an alternative development pathway or prolonging a mechanism with which to ensure the existing development trajectories to wider mitigation and adaptation initiatives. This is an important distinction, yet there has been little research addressing it, both conceptually and empirically.

To date much of the empirical research on CCD has been at the project level, analysing how initiatives such as climate smart agriculture are simultaneously lowering carbon emissions and improving rural livelihoods (Lipper et al., 2014). However, there has been significantly less research on the institutional adaptation and implantation of CCD at the national level where such initiatives and policies are developed and approved (Ficklin et al, forthcoming). This, in part, due to the complexity of contextualised framings of climate change and development issues and the diversity of how they are being integrated into policy frameworks. However, we argue that it is also because CCD is an emerging concept and there is not a clear conceptualisation of what CCD is, and how it differs from other development pathways such as ‘climate resilience’, ‘green growth’ and ‘low carbon development’. In this paper we compare and contrast the opportunities and challenges, motivations and resistance to creating an alternative CCD development pathway in Tanzania and Swaziland.

The research presented draws from semi-structured interviews with policy makers and stakeholders in the NGO and private sectors working at and across multiple levels, to provide the institutional perspective of CCD that is missing in the current literature. In addition, analyses from existing and forthcoming climate adaptation, mitigation, development policies for each country are presented. The data presented was analysed using coding software and thematic matrices to source similarities and distinctions between the two country contexts. We draw out key discourses around adaptation, mitigation and development, identify what kind of CCD is occurring, and how it is being performed. We also present and further findings on stakeholder engagement, analysing how CCD is being contextually understood and practised and whose definitions and values count at different levels.

Our data suggest that CCD rhetoric in policy is in its infancy and that its component parts are framed differently in each country context. Therefore triple-win thinking with adaptation, mitigation and development is being extensively considered in policy. However, as it is emerging it is provoking questions and debate about the definitions of adaptation, mitigation and development pathways. In part due to the complexity of contextualised national framings of climate change and development issues and how this affects the opportunities, challenges, motivations and resistance to CCD as a development pathway in two contrasting country contexts.

In analysing CCD as an alternate development pathway, this paper presents data about the conceptualisation and framing of climate change and development issues in Tanzania and Swaziland. Furthermore, it analyses how CCD rhetoric is shaping how adaptation, mitigation and development are defined in national policies and institutions, and the impacts this has on the opportunities and challenges presented by a CCD development pathway. Our analysis suggests that although CCD rhetoric is only just emerging, it is gaining traction with international financiers and national policy makers. As such future research on CCD development pathways in both national and regional contexts is required.
ways to reduce energy demand and energy-related greenhouse gas emissions around the world. With the adoption of energy efficient infrastructure and technologies often faces many barriers. One of the biggest barriers is the perception that improvements in energy efficiency reduce energy expenditure—access to predictable and affordable energy for infrastructure and manufacturing.

One of the most significant and influential sources of the benefits in developing countries is official development assistance (ODA) through bilateral and multilateral development institutions, such as USAID for International Development and the World Bank.

Unfortunately, ODA may actually be helping to perpetuate the use of inefficient infrastructure and technologies in developing countries. While international development agencies do finance energy efficiency investments—$200 billion between 2007–2013—they invest far larger sums in energy infrastructure and industry, without necessarily considering energy efficiency impacts. The extent to which ODA may actually be locking in energy inefficient infrastructure and industry—and thereby contributing unnecessarily to climate change—energy poverty, air pollution and other development challenges—is not well understood. And standards and best practice for mainstreaming energy efficiency into the core lending portfolios of international development institutions are not well developed.

ClimateWorks and Climate Advisors are currently researching and assessing the potential for energy efficiency improvements in current ODA financing in order to make recommendations to end energy inefficient ODA. Though difficult to quantify now because data is limited, such changes could deliver a massive reduction in climate change mitigation costs by developing nations. The project seeks to measure the global mitigation potential of ODA reform relating to energy efficiency and assess the politically feasibility of securing those reforms. The latest project research will be shared at the conference and discussion stimulated about the sectoral, institutional and regional focus, to ensure maximum progress in ending energy inefficient foreign aid.

P-4406-05

Need for Subtle Policy Changes to ensure Food Security under Climate Change: Perspective from Global South

LB. Kamepalli (1) ; SK. Pattanayak (2)

(1) Karnatak State Women’s University, Vijayapur, India; (2) Gulbarga University, Environmental sciences, Gulbarga, India

Food basket, in India as well the global South, over the years, became wheat/rice based but with inherent limitation of irrigated land. For instance, India has only 42.9% land equipped with irrigation. Rest of region that contributes to food basket of developing nations. The project seeks to measure the global mitigation potential of ODA reform relating to energy efficiency and assess the politically feasibility of securing those reforms. The latest project research will be shared at the conference and discussion stimulated about the sectoral, institutional and regional focus, to ensure maximum progress in ending energy inefficient foreign aid.

P-4406-06

Development perspectives of Sub-Saharan Africa under climate policies

M. Leimbach (1) ; N. Roming (2) ; A. Schultes, (3) ; G. Schwerhoff (3)

(1) Potsdam Institute for Climate Impact Research, Postdam, Germany; (2) PIK, Postdam, Germany; (3) Potsdam Institute for Climate Impact Research (PIK), Postdam, Germany

Reduction of global greenhouse gas emissions is at acceptable costs requires the inclusion of developing countries into a climate policy regime because their emissions grow rapidly. But the less developed countries fear to suffer in terms of economic growth and domestic wealth. This study focuses on Sub-Saharan Africa as the lowest income region and demonstrates how it could benefit from joining an international climate agreement without delay. Based on a scenario analysis with the Integrated Assessment model REMIND, we estimate the economic costs and transformation needs under different assumptions on the climate stabilization target, cooperation and technology diffusion. From simulation results it turns out that Sub-Saharan Africa will suffer aggregated consumption losses of up to 3% under a global tax regime, but can even gain under a cap-and-trade climate policy regime that starts early with cooperative action and consistently follows acknowledged equity principles.

P-4406-07

Trading off climate change mitigation and poverty eradication in developing countries: drivers and constraints to institutional change

B. Rennkamp (1)

(1) University of Cape Town, Energy Research Centre, Cape Town, South Africa, France

The assumption of a trade–off between climate change mitigation and poverty eradication generally goes unchallenged. The UN Framework Convention on Climate Change (UNFCCC) established that climate change responses take “into full account the legitimate priority needs of developing countries for the achievement of sustained economic growth and the eradication of poverty.” Development banks and other international development institutions are not well developed.

The theoretical contribution of the paper adds to the literature on institutional change in the studies of political economy. The paper identifies the drivers and barriers to institutions the change processes (e.g. Streeck and Thelen 2005). It establishes the argument that trade–offs and distributional conflicts are significant determinants of success or failure of institutional change.

The methodology is an innovative discourse network analysis combining qualitative discourse and quantitative network analysis (Leifeld 2012). The analysis shows how actors organize in competing coalitions in relation to others depending on whether they support or oppose a specific policy intervention.

The research design consists of three climate change mitigation policies in South Africa. (There will be more results from Mexico and Thailand coming out later this year). The three policies are the carbon tax, the renewable energy programs as put forward by the government and the National Climate Change Response White Paper (NCCR) process (RSA 2011). South Africa exemplifies the need for urgent emissions reductions and poverty eradication. The country’s emissions range with 0.9 Mt per capita at levels similar to Germany, while poverty...
levels remain at 39% counting the national poverty line of 390 Rand/~30 Euros per household per month (NPC 2011). The main source of greenhouse gas emissions is the coal dependent electricity and liquid fuels sector. All three policies were announced before the 17th COP held in Durban in 2011, but only the renewable energy program and the NCCR are under implementation. The analysis shows that the discourse in the debate on the carbon tax establishes trade-offs between economic growth, poverty alleviation and emissions reductions. Mechanisms to offsetting the carbon tax attempt to minimize these trade-offs. The reason for the lack of implementation lies in the distributional conflicts. The negotiations between the competing coalitions occur mostly without the participation of poor parts of the population and lack clear evidence of the impacts on low-income households.

References
[1] This study is part of the research project Climate Change Mitigation and Poverty Reduction (CLIMIP) funded by the Programme «Europe and Global Challenges»

4407 - The Challenges and Opportunities of Multilevel Adaptation Governance

ORAL PRESENTATIONS

K-4407-01

Adaptation principles and their application: Effective determinants for multilevel climate governance?
S. Kreft (1)
(1) United Nations University, Institute for Environment and Human Security, Bonn, Germany

The UNFCCC COP 21 climate summit in Paris at the end of 2015 is expected to yield a new agreement on climate change, that will provide the framework for international climate policy cooperation in the coming decades. Advancing adaptation to climate change is a political priority for many countries, especially island states and least developed countries, and a major expectation towards the outcome of COP 21.

At the international level there are emerging norms on the conduct of adaptation interventions – for instance through adaptation principles stipulated by the UNFCCC’s Cancun Adaptation Framework decided in 2010. The presentation addresses the question of how these principles are taken into account in programming adaptation actions by international funds and bilateral initiatives. Initial results based on a standardized analysis of board and programme policy documents as well as project documentation point to an uneven uptake and effect of internationally agreed adaptation principles on these institutions. I use these insights to discuss the effect of broad level policy principles on multilevel climate governance and adaptation practice, and to debate the relevance of an evolution of adaptation norms in the context of advancing the climate regime in Paris.

K-4407-02

Challenges of scales: exploring pathways to integrate locally-developed adaptation initiatives with national and regional deve-lopment plans and adaptation policies
S.Huq (1)
(1) International Institute for Environment and Development, United Kingdom

Abstract not communicated

O-4407-01

Opportunities for municipal climate adaptation: aligning local adaptation plans with provincial and national policy in South Africa
G. Zierevogel (1)
(1) University of Cape Town, Environmental and Geographical Science, Cape Town, South Africa

While some argue for a dedicated policy domain to focus on reducing climate impacts, others suggest that more comprehensive responses that integrate climate into existing policy domains are important. This presentation seeks to share the opportunities that enabled a local government municipality in South Africa, the Bergrivier municipality, to develop an adaptation plan that aligned with local development plans and provincial and national adaptation plans and initiatives and developments in national climate policy. We suggest that multiple opportunities converged to enable a municipal plan to be rapidly developed through a collaborative process that aligned with policy across different levels. The process built on the successful partnership between a range of scientists, local government and provincial government actors that worked together to develop a municipal adaptation plan. Key elements of success include ways that scientists worked with different levels of government, the flexibility of the process and the knowledge sharing and capacity strengthening this enabled. This knowledge exchange helped to strengthen understanding across the science – policy – practice divide, resulting in climate scientists having a better understanding of the multiplicitious complexity of local level governance and service delivery challenges, and by the same token, provincial and local officials and councilors gaining a better understanding of the complexity involved.
in producing locally relevant climate information. The research suggests that mainstreaming local climate adaptation plans with local development plans on one side and aligning local climate adaptation plans with provincial and national priorities on the other side, can help to create a conducive environment to co-producing local adaptation plans that aim to reduce both specific climate risk and meet generic socio-economic development needs.

O-4407-02

Limits and opportunities of private finance for adaptation in Least Developed Countries

D. Adis (1) ; T. Corrado (2) ; P. Pauw (3)

(1) Stockholm Environment Institute, Stockholm, Sweden; (2) Stockholm Environment Institute, United Kingdom; (3) German Development Institute, DIE, Bonn, Germany

Interest in private finance for climate resilience is increasing rapidly. A wide range of actors – finance institutions, intergovernmental organizations, policy-makers, negotiators, research institutions, insurers and reinsurers, and private investors themselves – have been quick to join efforts to further identify opportunities for private investment in developing countries. However, it is far from clear how the private sector might make a substantial contribution, particularly for adaptation, where actors struggle to assess the finance landscape have so far been unsuccessful. Research has shown that private adaptation finance has yet to prove its worth and the role of the private sector in adaptation and adaptation finance has received little attention from developing countries in the UNFCCC climate change regime.

This paper considers the limits and opportunities to stimulating private sector contributions for climate-resilient development. Its focus is on three aspects of climate finance governance – enabling environments, established and innovative mobilisation mechanisms, and delivery mechanisms – as well as their ability to ensure scaled-up finance for climate resilience, and developing-country accessibility to this finance.

Specifically, the paper questions the potential of private finance for adaptation in Least Developed Countries (LDCs). National Adaptation Programmes of Action (NAPAs) are used to indicate overall national adaptation priorities, and complemented with national development plans for selected countries. Foreign Direct Investment (FDI) is analysed as a proxy for where foreign private sector investments are, and the methodology is complemented with qualitative assessments of alternative forms of private investments, including green bonds, risk guarantees and mutual approaches. Through policy analysis and semi-structured interviews, the paper: 1) highlights the institutional and regulatory frameworks, as well as knowledge and cognitive aspects, which are currently a barrier for an investment-friendly enabling environment for the private sector; 2) the private sector assesses existing and innovative mechanisms for mobilisation of private sector investment; and 3) the paper’s third focus on delivery mechanisms maps private sector investments through participation (purely private and public-private) and scale (micro, meso, macro).

It is found that private sector flows to adaptation priority sectors are scarce, and their impacts on resilience often unclear. Increasing these flows would require that country-specific challenges be addressed. The paper highlights a lack of innovative mechanisms for LDCs and discusses limits and opportunities for multilateral climate funds, such as the Green Climate Fund, to attract and leverage private finance for adaptation in key sectors, including food security, water resources, health, and energy security and access. It concludes that climate funds need to seek a combination of climate change adaptation and social and economic development and employment in order to maximise private sector contribution, both financial and non-financial.

O-4407-03

Bridging Communication and Trust Building for Local Climate Adaptation: A Case Study of Tainan, Taiwan

R. Chen (1) ; H.C. Lee (2)

(1) Chinese Culture University, Taipei, Taiwan; (2) National Central University, Chung Li, Taiwan

Local implementation is a key to the overall efforts in response to climate change. In local settings, adaptation planning copes not only with various consequences induced by climate change, but the multiple interests raised by those affected stakeholders. Dissonance is commonly seen among different sectors with regard to agenda setting and response to climate change, a part of state-funded program, “Taiwan Climate Change Adaptation Technology” (TaiCCHAT), is designed to reveal and remedy the discrepancy among different policy sectors by focusing on a Taiwanese city, Tainan.

With a long colonial history Tainan is a vivid city of tourism and cultural events. However, as a municipality Tainan has an extensive jurisdiction covering urban, coastal, and rural areas. This diversity in life styles and ecosystems has invited severe vulnerability to extreme weather and its impacts, both floods and droughts. The primary investigation of this study has shown there are a series of asymmetries existing in policy participation, information sharing, resource allocation, and action taking among different sectors. Employing social network analysis, text mining techniques, and co-design research principles, this study further examines the contents of these discrepancies and aims to identify the key actors who are in the closest network proximity for the channels of communication and trust building for local adaptation initiatives and water resource management.

P-4407-01

Climate Change Adaptation: A Community Adaptation Small Grants Facility in South Africa

MA. Baudoin (1) ; M. Barnett (2) ; A. Bourne (3) ; C. Forbes (4) ; H. Karathanassis (4) ; Z. Jakavula (4)

(1) Climate and Development Initiative, Cape Town, South Africa; (2) South African National Biodiversity Institute, Cape Town, South Africa; (3) Conservation South Africa, Springsbok, South Africa; (4) SouthSouthNorth, Cape Town, South Africa

Internationally, there is increased funding for Climate Change Adaptation (CCA) projects, especially in support of bottom-up or locally-driven initiatives. This recent emphasis stresses the relevance of local knowledge and practices in risk management – including dealing with climate variability and change. It also attempts to avoid top-down adaptation plans that often fail to address local climate vulnerability and needs. As a response to climate change, bottom-up approaches build on existing knowledge and practices to propose locally-relevant adaptation strategies. Moreover, bringing adaptation to communities provides more tangible impacts at the local level.

The Adaptation Fund (AF) is one of the international institutions promoting this approach. The AF is currently pioneering a direct access climate finance modality where developing countries can directly receive financial support for CCA, without working through an intermediary. This presentation describes the project “Taking Adaptation to the Ground: A Small Grants Facility for Enabling Local Level Responses to Climate Change”, which is an initiative of the South African National Biodiversity Institute (SANBI). SANBI is the National Implementing Entity for South Africa, accredited by the AF, and works with and through the Department of Environmental Affairs, who is the National Designated Authority. The Community Adaptation Small Grants Facility (SGF) project aims to enhance resilience to anticipated climate change impacts in two project target areas in South Africa; the Mopani District Municipality (Northern Cape Province) and the Namakwa District Municipality (Limpopo Province). The project’s Executing Entity is Mopani and the Facilitating Agency for Namakwa is still to be appointed.

Poor, vulnerable communities often lack the capacities to access adaptation funding and to implement well-informed adaptation measures. To ensure that climate finance for adaptation activities reach those most at
risk, the SGF pioneers a community-driven CCA initiative that involves engagement with local stakeholders and beneficiaries in project development and implementation. Three main components will be implemented: 1) providing small grants to vulnerable communities for projects that deliver tangible and sustainable benefits; 2) empowering local institutions to identify and implement adaptation actions; and 3) compiling and sharing lessons to facilitate future up-scaling and replication of enhanced direct access modalities.

The SGF approach is, thus, an example of an internationally-funded initiative that is rooted firmly on the ground, focused specifically on providing direct access modality for climate finance under the AF. Through the learning component of the project, lessons will be identified, collected and shared in order to provide recommendations for improving the uptake of direct access in South Africa and beyond. This presentation will explore opportunities and challenges of bottom-up approaches for adaptation and the interplay between adaption to management and execution at different levels of the SGF project.

P-4407-02

Considering one’s options when the fish leave: A case study of the traditional commercial hand line fishery of South Africa’s Southern Cape region

L. Gammage (1) ; C. Mather, (2) ; A. Jarre, (1)

(1) University of Cape Town, Marine Research Institute (MARE) & Department of Biological Sciences, Rondebosch; (2) Cape Town, Stellenbosch University, Department of geography, St John’s, Canada

Many pressures (socio-economic, resource scarcity, policy, and regulation) make small-scale fishers and their communities vulnerable on a variety of fronts. Fishers need to cope with local and global changes and require solutions for strategies to achieve resilience. The impact and interplay of these stressors at multiple scales need to be taken into account to develop a clear understanding of social–ecological linkages if sustainable livelihoods are to be guaranteed. However, there is a shortage of appropriately scaled, context-specific data, which is needed to inform various decision-making processes.

The present study researched vulnerabilities, as well as coping and adaptation in the small-scale, commercial handline fishery in six communities of South Africa’s Southern Cape region. Fishers and the factors that typically foster, block or inhibit learning have been explored. The wide array of alternative income options and the scarcity of fish buyers and other persons associated with the fishery. Faceted with multi-scale changes to the broader fishery system, these fishers are forced to employ a wide range of strategies to cope and adapt to change. These changes, driven by multiple stressors on various spatial and temporal scales, affect not only the region overall, but display much variation in the impact felt by both individuals and individual communities. Not only are fishers required to cope with, and adapt to variability in the biophysical system, but they are also subjected to social and economic pressures as well as those created by policy and decision management decisions. Exemplified by high variability found in the natural environment with specific reference to weather fluctuations and the scarcity of the primary target species, pressures created by a perceived inadequacy of regulatory oversight and the administration of fishing rights as well as pressures created by increased input costs and cost of living. Notably, these fishers have very little to no control over most of these stressors, as many of these changes are the result of other, larger-scale developments and events, from which they are disconnected.

The coping and adaptation strategies employed by these fishers can be grouped into three main groups with socio-economic conditions and life histories of individuals within the six communities seemingly the biggest determining factor. In this context of situated learning, and sociocognitive and multi-level decision-making processes are shaped by the experience of their past and present environments of both individuals and their communities and cannot be understood by direct impacts of stressors alone, which highlights the need to understand indirect effects and feedback loops in the future. Practical implications of actions are not always the overriding concern in decision-making, underscoring the importance of culture and belief systems in decision-making. The severity of the challenges experienced with policy and regulatory processes may be exacerbated by a strong resistance to change, and the varying levels of resilience displayed by the different communities may be viewed in both a positive and negative light. Whereas one group of fishers have modernised their business strategies and intensified their fishing by going further offshore on larger, but more economic craft, the second and third group of fishers navigate the status quo because it is ‘what they know’. The second group, characterised by low formal education and a strong and political marginalisation in the third group are not comfortable making, especially when considering implications of the implementation of a recently legislated small scale fisheries policy. Coupled to this is an unwillingness to accept that the biophysical system may not always return to, or be able to return to, its former state, exacerbated by current considerable scientific uncertainty of climate dynamics in this region.

P-4407-03

The approaches to learning in multilevel adaptation governance research – a systematic literature review

J. Gonzales Iwanciw (1) ; A. Dewulf, (2)

(1) Universidad Nur, Development Studies, La Paz, Bolivia; (2) Wageningen University, Public administration and policy group, Amsterdam, Netherlands

Within just the last few years the governance of adaptation to climate change has become a truly multilevel affair from global to local levels. International institutions like the UNFCCC are currently aiming at an enabling framework to support adaptation governance at national and local levels, but also “local” and national actors are increasingly taking an active role in international policy processes and seeking such conditions that they can become involved in shaping these creating an emerging multilevel institutional context. In this context learning has been recognized as a central mechanism for individual and collective actors in adaptation at different governance levels to better adjust their responses to environmental change and uncertainty.

Climate change adaptation has been addressed in the literature mainly as a local or regional activity and thus learning has been also mainly attributed to the participation of local actors. From a multilevel perspective learning and learning-loops happen in layers from individual to groups to institutional/social at different governance levels. In this context the notion of multilevel adaptation governance, as the one shaped by the UNFCCC learning will be needed across different governance levels to be effective in pursuing adaptation goals, adequate to the scale and magnitude needed, and ensure a better fit between top-down and bottom-up approaches.

This motivated the systematic literature review of learning in multilevel governance of adaptation to climate change presented in this paper.

The paper analyzes how learning has been addressed both in the general multilevel governance literature and in the climate change adaptation governance literature. The paper summarizes a typology of learning as described in multilevel governance literature and a literature review, discussing the concept of learning emerging from this two literature branches, the main methodological approaches used to assess and measure learning, different learning types and the factors that typically foster, block or inhibit learning in the way it is viewed by the literature.

The review contrasts these results with additional insight from policy learning and social learning literature, which are frequently used in multilevel governance and climate change adaptation literature to discuss the implications for multilevel governance and climate change adaptation governance literature and extract the elements for conceptualizing multi-level learning in the governance of climate change adaptation.
The role of residents in climate adaptation: a systematic overview of default and alternative roles

D. Hegger (1) ; P. Driessen (1) ; H. Runhaar (1) ; H. Mees, (1) (1) Environmental Governance, Copernicus Institute of Sustainable Development, Utrecht university, Utrecht, Netherlands

Literature on roles and responsibilities of public and private actors in climate adaptation has hitherto devoted limited attention to the roles of residents (homeowners/tenants). Their role is crucial in addressing non-adaptation, as their initiative or consent is often necessary to take private property level adaptation measures. This paper provides a systematic sketch of default and alternative roles of residents in climate adaptation, based on a review of literature on the climate adaptation actions of residents. This covers three forms of residents’ commitment to adaptation: (a) as citizens falling under the jurisdiction of various governmental levels; (b) as consumers (including home owners) in the market; (c) as civil society members. The overview suggests that there would be scope for alternative roles for residents in climate adaptation, especially regarding the latter two forms of commitment. The paper also discusses implications for research into and practice of adaptation governance.

Sustainable Climate Change Adaptation through Community Organizing and Participation: The Case of Bakhawan Eco-Park in Kalibo, Aklan, Philippines

E. Serrano (1)
(1) University of the Philippines Los Baños, Institute for Governance and Rural Development, College of Public Affairs and Development, Los Baños, Laguna, Philippines

This study aimed to analyze how community organizing and participation helped ensure sustainable climate change adaptation in Kalibo, Aklan, Philippines. Through key informant interviews, focus group discussions, and other personal communications, data were collected primarily from community members, local leaders, and development workers. Data were analyzed qualitatively.

It was found out that sustainable climate change adaptation takes place through collaborative action. It involves the participation of the local government, people’s organization, community members, the academe, the private sector, and other government agencies. Findings also show that pooling resources, mobilizing the community, and providing livelihood opportunities enhanced adaptive capacity.

Since sustainable climate change adaptation requires the active engagement of different sectors of society, community mobilizing and participation should be given more importance in climate change adaptation interventions.

Interpretation of adaptation to climate change and governance

G. Simonet (1)
(1) CDC Climat Recherche, Paris, France

Over the last decade, many studies have focused on the institutions responsible for managing climate risks by analyzing responses, limits or barriers. Several studies have explored this path by focusing on the sources of the cognitive barriers that prevent actions, on the reasons and aspects of interests that motivate the denial and on the influence of cognitive factors on decision-making. Today, it has been widely acknowledged that people’s beliefs and perceptions influence implementation of climate change adaptation. Regarding perception barriers, some authors keep highlighting the confused definition of adaptation and its various interpretations. However, few studies explored these issues directly with local policy makers who work directly on the elaboration or the implementation on adaptation strategies to climate change. Moreover, a clear definition of what really means “adaptation to climate change” is still working in progress, letting local authorities with their own interpretation of the notion.

Based on this framework, the ABSTRACT-colurba was launched in January 2014 by CDC Climat Recherche and two French public agencies (ADEME and AFD). The project proposes to increase knowledge on climate risk management at the urban scale by analyzing the levers and barriers (economic, organizational, cognitive) attached to decision-making processes upstream to the implementation of adaptation strategies to climate change. Based on a field study through 10 French local urban communities, the project is conducted within an action-research approach integrating local stakeholders. More specifically, the focus of the project is made on the intermediate size urban areas (50.000-100.000 inhabitants) chosen through different criteria (local dynamism, awareness, diversity of issues). Based on interviews and focus groups directly collected in the region of Bangladesh currently experiences livelihood and food insecurity as a result of the impacts of climate change. In particular, large numbers of people are being
displaced, either through a temporary move to find work during the lean seasons, or a permanent move to another place to avoid the unstable living conditions experienced in these vulnerable coastal districts. Our second finding is that the climate change adaptation initiatives currently implemented in these vulnerable coastal districts of Bangladesh are inadequate to support the huge number of people affected by the impacts of climate change in a way that will ensure the security of their livelihood. According to the UN report, a significant portion of the population in these countries is at risk due to the impacts of climate change.

The presentation will provide an overview of the ABM, the modelling of a spatially coherent probabilistic surface water flood event set, and highlight the key findings of the analysis of the current and proposed public-private partnership for risk reduction. It will highlight benefits and limitations of the current and proposed scheme, and provide recommendations for the scheme in order to help promote flood risk reduction and increase resilience in London.

4408 - Risk and Insurance

ORAL PRESENTATIONS

O-4408-01
The role of insurance for flood risk reduction in London: An agent based model approach

K. Jenkins (1); J. Hall (1); S. Surminski (2); F. Crick (3); I. Nikolic (4); J. Dubbelboer (4)
(1) University of Oxford, Environmental Change Institute, Oxford, United Kingdom; (2) GranthamResearch Institute on Climate Change and the Environment | London, United Kingdom; (3) GranthamResearch Institute on Climate Change and the Environment, London, United Kingdom; (4) Section Energy & Industry, Faculty of technology, policy and management, Delft University of Technology, Netherlands

Flooding is recognised as one of the most common and costliest natural disasters in England. In London surface flooding is considered to be the most likely cause of flood events, and probably the greatest short-term climate risk. More than 8,000 properties are estimated to be at risk, and while most drainage systems are designed to cope with a 1/30 year storm event, maintenance is often poor and parts of the network can perform below these standards.

A particularly interesting aspect of flood management is the role of insurance for flood risk reduction. Flood insurance mechanisms can influence the public’s perception of flood insurance between the UK government and the insurance industry. Flood insurance is underwritten by the private market, while government commits to flood risk management activities. However, this agreement is currently being under review with a new insurance system, Flood Re, proposed. The proposed system, which creates an insurance pool for properties at high risk of flooding, is presented as a way to reduce the impacts of flooding through charging risk-based premiums. This model also takes into account future affordability and availability of flood insurance, which is anticipated to run-time of 20 to 25 years. The mechanisms of the new Flood Re scheme are still being negotiated, and to date there is little mention of how the partnership between government and insurers, and the new Flood Re scheme could also promote effective flood risk reduction measures.

In order to investigate this partnership an Agent based Model (ABM) has been developed for Greater London. The ABM characterises different agents: property owners, insurer, developer, government, and bank, which interact within the environment. The ABM has been designed such that it can investigate the public-private partnership and the spatialisation of surface water flood risk, and how the current and future proposals for the partnership could influence London’s resilience to surface water flood risk today and in the future under various scenarios of climate change. The model can address include the effect of surface water flood risk and insurance on household wealth; consequences of flood damage and insurance unavailability for the housing market; and the role of incentives for risk reduction among different partners (including the government, insurers, and developers) to support flood defences, household level flood protection, and more appropriate spatial planning.

Ultimately, the model aims to highlight the potential benefits and limitations of the proposed Flood Re scheme for risk reduction, and test various options for the scheme, such as the inclusion of certain types of properties, and the financial implications of different transitional pathways to risk-based pricing of insurance in the longer-term. The model and research is highly relevant for the ongoing regulatory and political approval process for Flood Re, which have until now not received sufficient attention due to lack of data or analysis.
Weather index insurance in a changing climate

J. Daron (1); D.A. Stainforth (2)
(1) UK Met Office, Applied Climate Science, Exeter, United Kingdom; (2) London School of Economics, Grantham Research Institute, London, United Kingdom

Insurance and risk transfer products are increasingly being made available to low income households in developing countries to protect livelihoods from extreme weather and climate events. Index insurance products – where premiums and payouts are based on a proxy for loss (e.g. total seasonal rainfall) rather than the actual economic losses suffered – typically have lower administration costs, and therefore premium rates, than traditional claims based insurance. Furthermore, payouts are made immediately when the proxy is triggered, thus reducing the time between a loss event and the receipt of an insurance payout. Various proponents, including the United Nations, have therefore supported the widespread dissemination of weather index insurance as a means to reduce vulnerability to weather extremes in low income communities. However, like most lines of climate-related insurance, weather index insurance products are typically designed using historical observed data only. It has not previously been well investigated how climate change might impact the viability of weather index insurance products.

It is with this background that we developed and demonstrated a method for assessing the viability of weather index insurance under altered climate conditions (Daron and Stainforth 2014). We utilise Bayesian Networks, which are graphical networks that propagate probabilities between variables and outcomes of interest. In our study, we develop them as a tool for exploration – to help understand sensitivities and support insurers in assessing pricing structures and assumptions with different climate information. We apply the tool to a case study of weather index insurance for the rice crop in Kolhapur, India.

A hypothetical weather index insurance product is used in Bayesian Networks of increasing complexity that include different sources of climate information. We include observational rainfall data in addition to output from the UK Met Office Hadley Centre regional climate model (HadRM3), driven by model reanalysis data (ERA-Interim) and general circulation models from the Hadley Centre (HadCM3) and Max Planck Institute for Meteorology (ECHAMS). We show that the model data significantly underestimates the historical observed data and therefore question the reliability and utility of the climate model output. Furthermore, we discuss how observations can also be subject to errors and uncertainties.

Depending on the choice of input data, and the process of combining different datasets, we determine very different implications for the viability of the weather index insurance product under climate change. Yet the purpose of the study is not to provide definitive answers of how climate change might impact weather index insurance in the case study region. Rather it is to demonstrate a possible method for combining multiple data sources to inform insurance decisions.

We conclude that without consideration of multiple sources of climate information, and an acknowledgement of the associated biases and errors, insurers are likely to miscalculate and misrepresent the underlying climate hazard risks with potentially adverse implications for policyholders. Used to understand the sensitivities of pricing structures and premiums to different sources of climate data, the Bayesian Network method shows promise as a potential tool to help insurers in making pricing decisions. However, the current generation of climate model output is shown to be of limited value and difficult to use by index insurance practitioners. We therefore caution that in the context of climate change, the absence of reliable, robust, quantitative model projection data means that choices considered optimal based on today’s available model information may lead to maladaptation and risk significant losses to insurers in the future.

References:
Daron, J. D. and D. A. Stainforth (2014) Assessing pricing assumptions for weather index insurance in a changing climate. Climate Risk Management, 1, 76–91

Sharing of Climate Risks across World Regions

J. Emmerling (1)
(1) FEEM, Milano, Italy

Uncertainty is prevalent in the context of climate change impacts. Moreover, the distribution across the globe is not uniform. We analyze how climate risks could be reduced via an insurance scheme at the global scale across regions and quantify the potential welfare gains from a such a scheme. Starting from the standard welfare analysis in Integrated Assessment Models (IAMs), which assumes no risk sharing across region, we introduce global risk sharing via a market for state-dependent Arrow-Debreu securities. We show that this allows equalizing relative consumption differences between states of the world across regions. We estimate that such risk sharing scheme of climate risks could lead to welfare gains reducing the global costs of climate change by up to one third, while the amount of transfers required is substantial. This provides arguments for considering risk sharing in IAMs, but also for potentially welfare increasing negotiations about sharing risks of climate change at the global level.

On the cost of climate change for an insurance company

E. Masiello (1); D. Kortschak (2); P. Ribereau (1)
(1) Université Lyon 1, Institut Camille Jordan, Lyon, France; (2) Institute for Economic and Innovation Research, Joanneum research, Graz, Austria

Climate change is of great concern for insurers because of increasing in frequency and intensity of extreme weather events which may represent some very serious insolvency issues. From a mathematical point of view, we derive asymptotics for the ruin probability of the insurance company in a risk model which has been updated in a way to take into account projected changes in some specific weather-related events like tropical storms for example. In practice, the results obtained so far are used to try to calculate the cost of climate change for an insurance company in a simplified portfolio. Some examples are presented to illustrate the theory.
4409a - The «new» climate governance: Driving societal transformations?

ORAL PRESENTATIONS

K-4409a-01

The Evolving Role of the UNFCCC in Global Climate Governance: From Regulator to Facilitator?

H. Van Asselt (1); F. Zelli (2)

(1) Stockholm Environment Institute, Oxford, United Kingdom; (2) Lund University, Lund, Sweden

It is widely acknowledged that the United Nations Framework Convention on Climate Change (UNFCCC) does not operate in isolation in global climate governance. Governance of climate change and options for improving its effectiveness are not properly understood through an exclusive focus on one of its elements (e.g. the UNFCCC process), but require examining how various elements work in conjunction. Such a broadened focus draws attention to the potential facilitative and catalytic role of the UNFCCC, an aspect that has been largely overlooked by commentators and has only recently received more attention in the Durban Platform negotiations on a future climate agreement. The paper explores this possible new role for the UNFCCC, in which it can keep track and review the outcomes of other actions, and strengthen them where possible. It explains the rationale for the new role, and highlights opportunities for as well as risks of ‘outsourcing’ parts of global climate governance to other international and transnational institutions, focusing in particular on the case of short-lived climate pollutants (SLCPs). The case is of high relevance since a variety of intergovernmental and public–private institutions have started to tackle SLCPs, such as black carbon and tropospheric ozone, including intergovernmental agreements such as the Montreal Protocol as well as new public–private partnerships such as the Climate and Clean Air Coalition. The paper concludes that a better understanding of the UNFCCC’s facilitative role leads to a more nuanced assessment of the achievements of the UNFCCC in global climate governance.

K-4409a-02

National climate governance. National Climate Policy Activity

D. Huitema (1); A. Jordan (2)

(1) VU University Amsterdam, IVM, Amsterdam, Netherlands; (2) Tyndall Centre, ENV, Norwich, United Kingdom

States have been widely criticised for failing to advance the international climate regime. Many observers now believe that a “new” climate governance is emerging through transnational and/or local forms of action that will eventually plug the resulting governance gaps. Yet states, which remain oddly absent from most discussions of the “new” governance, will remain key players as governance becomes more polycentric. This presentation is based on two special issues (both edited by Andrew Jordan and Dave Huitema) that explore the ability of states to rise to these interconnected challenges through the analytical prism of policy innovation. We reveal that policy innovation is much more multi-dimensional than is often thought; it encompasses three vital activities: invention (centering on the “source” of new policy elements), diffusion (that produces different “patterns” of policy adoption), and the evaluation of the “effects” that such innovations create in reality. The papers in the special issues, which range from qualitative case studies to large “n” quantitative studies, offer new insights into the varied roles that states play in relation to all three.

They show, for instance that: the policy activity of states has risen dramatically in the past decade; that state innovation is affected to similar degrees by internal and external factors; and that policies that offer flexibility to target groups on how to meet policy goals are most effective but that voluntary reporting requirements are ineffective. This presentation draws upon these and many other insights to offer a much more nuanced reflection on the future of climate governance; one that deservedly puts states at the front and center of analysis.

K-4409a-03

Transnational Climate Governance: Performance and Future Prospects

M. Betsill (1)

(1) Colorado State Univ, Political Science, Colorado, United States of America

Today, the governance of global climate change takes place in a complex, multi-level and multi-actor landscape through a wide range of mechanisms such as multilateral treaties, carbon markets, certification schemes, urban planning codes, corporate sustainability programs, and so on. Critical to this transformation is the emergence of transnational governance arrangements which cut across traditional state-based jurisdictions and operate across public–private divides. This talk will present the findings from a recent international research collaboration (Bulkeley et al., Cambridge University Press, 2014) analyzing transnational climate governance arrangements to better understand the emergence, nature and consequences of this phenomenon and consider the broader implications for global climate governance.

K-4409a-04

‘The political economy of contending pathways to de-carbonisation’

P. Newell (1)

(1) University of Sussex, brighton, United Kingdom

Drawing on recent work on the politics of green transformations, this presentation will apply insights on competing pathways to sustainability to the case of de-carbonising the economy. It will look at a range of state-led, market-led, technocentric and civil society-led transformations, drawing both on contemporary and historical examples, to explore what light they shed on our ability to de-carbonise the contemporary global economy.

4409b - Climate Governance: New and emerging challenges after Paris

ORAL PRESENTATIONS

K-4409b-01

Paris and beyond: strengthening the research-policy interface

A. Sagar (1)

(1) Indian Institute of Technology Delhi, Humanities and Social sciences, Delhi, India

While there has been some progress in the climate negotiations as well as in the broader climate arena, this still is not commensurate with the magnitude and urgency of the climate challenge. Therefore identifying the key issues underlying major roadblocks in the climate policy arena and then exploring way of realistically overcoming such roadblocks could be of great help. The Global Climate Policy Conference, which will be held in Delhi in April–May 2015 aims to provide an opportunity to research scholars...
from around the world, selected through a competitive, rigorous evaluation process, to present their ideas on how to overcome roadblocks in the climate policy arena and also bring together a set of leading international experts to discuss specific key policy issues where research and analysis can contribute to improved climate policy-making. This session will present the best ideas discussed at the conference, along with their anticipated impact on climate policy-making at Paris and beyond.

**K-4409b-02**

**Transparency and Accountability in Global Climate Governance**

A. Gupta (1)

(1) Wageningen University, Environmental policy group, Wageningen, Netherlands

In this paper, we review recent scholarship and the state of the art on the nature and consequences of a transparency turn in global climate governance. Transparency, as information disclosure, is being embraced by public and private climate governance arrangements, including, inter alia, the United Nations Framework Convention on Climate Change (UNFCCC) and the Carbon Disclosure Project, as a way to monitor and/or reward various actors’ climate mitigation performance. Such “governance by disclosure” is intended to further a variety of goals, including empowering recipients to exercise informed choice or hold disclosers to account for their (non-)performance, and improving sustainability performance. Our review assesses these posited relationships between transparency, accountability and sustainability in climate governance. We conclude by deploying our own “critical transparency studies” perspective, one that views information itself as fundamentally contested political terrain, to assess the transformative potential of transparency and informational governance in the climate realm.

**K-4409b-03**

**The Legal Nature of the Paris Agreement: Much Ado About Nothing?**

F. Sindico (1)

(1) Strathclyde Centre for Environmental Law and Governance, 16 richmond street, Glasgow G1 1XQ, Scotland, United Kingdom

In 2009 at the Copenhagen UNFCCC Conference of the Parties protesters had banners stating “We will not legally binding, we want a fair, ambitious and legally binding agreement”. Ever since since Copenhagen the international climate change legal regime has experienced a metamorphosis from a top down to a bottom up approach, the APD does not have to rely on a legally binding agreement. Nevertheless, the ADP is currently negotiating a protocol, another legal instrument or an agreed outcome with legal force under the Convention applicable to all Parties. Against the backdrop of the increasing debate between legally binding and non-legally binding climate change policy avenues, this presentation will discuss each one of these three options and its relevance post Paris.

In the first part of the presentation the status of the current negotiations will be addressed in order to determine whether or not a protocol, another legal instrument or an agreed outcome with legal force under the Convention applicable to all Parties has received more traction. Taking as a starting point that the level of ambition embedded in any of the three outcomes will most likely need to be upgraded if the Paris Agreement is to meaningfully deal with climate change in the long term, the second part of the presentation will seek to explain why some countries are still aiming for a legally binding outcome only in order of maybe $30 per ton of CO2 in 2050. With that level, natural gas would press out oil and coal, unless CCS would become considerably cheaper than for fossil energy. When fossil fuels start to get pressed out of the market, their prices can be very low, for a very long time. Coal, always cheap, is joined by cheap oil and gas. At $40 per barrel. Oil earnings, the extreme CO2 emission reductions required for climate stabilization just will not happen, how good intentions may be. Renewables will lose the uphill battle, even if winning some niche fights. So generic table carbon pricing is a must, replacing partially applicable and volatile cap-and-trade systems like the EU-ETS.

The administrative implementation of carbon pricing, through Duties & Excises, is relatively simple. Most countries have hundreds of years of experience. A post-Paris agreement can be based on an equal level of national carbon emission taxes, administered upstream as an excise on primary fossil productions and imports, with a refund upon export and CCS, similar to taxing alcoholic drinks. A CO2 emission tax would result.

The post-Paris agreement would have at its core an equal level of the emission tax between Parties, slowly but steadily rising to releve not only national levels but at the international level of maybe $300 per ton of CO2 in 2050. With that level, natural gas would press out oil and coal, unless CCS would become cheap enough. Relative to intermittent renewables natural gas might remain competitive in some contexts, but with CCS applications combined with CCS. The proceeds of the tax would correspond to actual national emissions, also in EU member states. Nobody will pay more than what is due, and tax authorities don’t go for less. Such opposed interests are essential for effective implementation.

**K-4409b-04**

**Accepting reality: we need new post-Paris governance for effective long term climate transformation**

G. Huppes (1) ; P. Drummond (2)

(1) Leiden University, CML, Industrial Ecology, Leiden, Netherlands; (2) University College London, Institute for Sustainable Resources, London, United Kingdom

Using the Grubb framework for analyzing climate policy, it seems that current negotiations center around short term policy approaches in his Domain 1 and 2, while our common future depends on deep long-term transformations, in Domain 3. Also, the Domain 1 UN discussions assume some central authority to ultimately regulate behavior on this globe, with a Binding Agreement on yearly allowable emission capped per country. This seems not feasible for basic reasons. First, risks are uncertain and are very different for different countries. Next, there is no agreed-upon equity principle, with deeply conflicting justice concepts. Also, under a binding agreement, countries growing faster than expected would have to buy permits from lower growth countries. Next, effective implementation is not only legally but also politically and administratively in many if not most countries. And economically, if a binding cap were implemented through tradable permits, the inherent price instability of a fixed cap could hardly guide long term technology development and implementation. Most basically, the Binding Agreement would not really be binding because there is no central enforcement mechanism. With currently applied cap-and-trade systems at the national level those getting around the many corners – politically and administratively or through corruption – will earn substantial amounts of money. It seems quite unrealistic to expect such an interventionist type of policy to drive deep societal transformations.

The current move in discussions towards more bottom-up governance mechanisms is an essential step, as it is at that decentralized level that creativity resides. However, bottom-up governance can hardly counter strong market forces in a globalized capitalist system. Cheap coal, oil and gas are available way beyond the 2, 4, and even 6 degrees climate target. Incentive structures will have to be changed in the core institutions of our global capitalist society for the deep transformations required.

For climate effectiveness generic, encompassing emissions pricing therefore is a sine qua non. Expectations on long term costs for non-fossil energy are much higher than for fossil energy. When fossils start to get pressed out of the market, their prices can be very low, for a very long time. Coal, always cheap, is joined by cheap oil and gas. At $40 per barrel. Oil earnings, the extreme CO2 emission reductions required for climate stabilization just will not happen, how good intentions may be. Renewables will lose the uphill battle, even if winning some niche fights. So generic table carbon pricing is a must, replacing partially applicable and volatile cap-and-trade systems like the EU-ETS.
The agreement does not need to be a global one to start with. Major powers, like China, EU and US, could start as the Climate Block, open to all others to join on equal conditions. Those not joining would be confronted with an excise on their fossil energy products upon export to the Block. This is not an import tax but an upstream emission tax, treating imports the same as national production. Border Tax Adjustments might also be introduced, on imported products with high emissions abroad, not yet taxed there. Joining the group of emission taxing countries would be attractive. This simple international climate agreement seems most feasible politically, administratively and economically. This institutionalist approach seems a most realistic post-Paris option.

This article explores the evolution of the citizenship participation in the Chilean climate change governance, mainly expressed during the public policymaking processes, leads by the Environmental Ministry. The different state of proceedings information, the public consultation process, and the answers to the questions raised have been fundamental to monitor the real impacts of the citizenship intervention.

As a global conclusion is possible to observe a slow but sustained and effective increase in the participation levels, contrasting with others on-going process which are being carry out in the region.

Preferences for Energy Efficiency vs. Renewables: How Much Does a Ton of CO2 Emissions Cost?

Concerns about climate change are growing, and so is the demand for information about the costs of mitigating greenhouse gas emissions. This paper seeks to estimate the benefits of climate change mitigation, as measured by the public’s willingness to pay for such policies. We investigate the preferences of Italian and Czech households towards climate change mitigation policy options directly related to residential energy use. We use conjoint choice experiments, which are administered in a standardized fashion to representative samples in the two countries through computer-assisted web interviews (CAWIs).

In our choice experiments, the alternatives are policy packages described by four attributes: i) the goal of the policy, i.e., addressing energy efficiency or promoting renewable energy; ii) the policy mechanism(s) (which may encompass one or more of the following: incentives, taxes on fossil fuels, standards or information); iii) the reduction in CO2 emissions per household, and iv) the cost of the policy to the respondent’s household. Items iii) and iv) are expressed as per year for each of 10 years.

The questionnaire was self-administered using CAWI by a total of 1385 respondents. The Italy survey was conducted in July 2014. The Czech Republic survey was similarly structured, and the section of the questionnaire dedicated to the renewables or energy efficiency policies, and the associated discrete choice experiments, was identical to that in the Italy survey instrument (translated into the Czech). The design of the choice experiments was likewise identical across the two surveys. The Czech Republic survey was conducted in August and September 2014 using CAWI and yielded a total of 1385 completed questionnaires.

The responses to the policy choice questions appear reasonable: About 40% of the Italy survey respondents selected program A, 37% program B, and 23% opted for the status quo. The Czech shares are, 33%, 36% and almost 31% respectively. The Czech respondents were thereby more often than the Italians, implying that their WTP for the policy packages is lower. Responses are stable over the choice exercises, and there is no evidence of anomalies or unusual peculiarities of the design in case for both the Italy and the Czech Republic respondents.

We fit the conditional logit models separately for the Italy and Czech Republic samples. The results from the Italy sample are reasonable and suggest that individuals were correctly trading off the attributes of the policies when selecting their most preferred ones. The status quo is the most preferred category, and so the positive and significant coefficients on the energy efficiency and renewables dummies indicate that these policies were generally preferred over the status quo. However, the coefficient on the renewable dummy is greater than that on the energy efficiency goal dummy, and a Wald test indicates that they are significantly different from one another at the conventional significance levels. Our survey respondents also have a preference for incentives over other implementation options. The coefficient on fossil fuel taxes is negative and significant, and similar in absolute...
magnitude to those on energy efficiency standards and incentive-based approaches, but the latter two are statistically significant only at the 11% and 5% levels, respectively.

The larger the CO₂ emissions reductions delivered by the program, the more likely is a respondent to choose a policy, and the lower the cost, the more attractive the policy, all else the same. These effects are strongly significant at the 1% level. The results from the surveys indicate that respondents prefer policies that promote renewables over policies that target energy efficiency, and, all else the same, they prefer incentive-based standards and infinibased approaches. The respondents in the two countries differ sharply in terms of their preferences for fossil fuel taxes: The Italians have a strong dislike for them, but the Czechs and Australians overwhelmingly prefer policies to pay per ton of CO₂ emissions avoided is €130 from the Italy sample and CZK 1514 from the Czech sample, and implies an income elasticity of willingness to pay equal to one.

P-4409-04
'Top Down' AND 'Bottom Up' AND 'Sideways' Climate Governance Solutions: The Realities, Potentials and Perils of a Pluralistic International Landscape
T. Brewer (1)
(1) ICTSD, Climate Change Global Platform, Geneva, France

The chapter on ‘International Cooperation’ in volume 3 of the IPCC AR5 documents that the international climate change discourse is increasingly conceptualized as a collection of institutional arrangements that include hierarchical ‘top down’ relationships (as in the multilateral UNFCCC) as well as ‘bottom up’ initiatives (such as unilateral subnational mitigation and adaptation programs). There are also ‘sideways’ relationships (such as those among cities), and there are also ‘sideways’ relationships between climate and non-climate regimes. Institutional proliferation along multiple pathways has likely included, in principle, each of the distinct linkages among carbon markets. These realities of a pluralistic institutional landscape should be taken into account in order for effective new international institutional arrangements to be devised; ignoring these proliferating tendencies could result in a dysfunctional fragmented international ‘system.’ Each pathway has its own distinctive criterion-based approaches and disadvantages, but the latter two are standard evaluative criteria: effectiveness in promoting climate change mitigation and/or adaptation, equity in the distribution of benefits and costs, economic efficiency, political acceptability and administrative feasibility. Analytic work and diplomatic initiatives are needed to develop pathways that will ensure collaboration and coherence among diverse institutional arrangements.

This presentation explores the implications of these observations for international institutional design. Empirical data and case information are drawn from the energy sector and the international transport sector, which are of course inherently significant in terms of their contributions to greenhouse gas and particulate emissions. The sectors are also significant for international institutional design issues because of their differences and interactions. The international maritime shipping industry is subject to regulation by the International Maritime Organization (IMO) as per provisions of the UNFCCC. The sectors of emissions of carbon dioxide, methane, nitrous oxide, and black carbon are thus potentially covered by the IMO. At the same time, the Arctic Council and the Clean Air and Climate Coalition (CACC) also have black carbon and methane on their agendas, and the World Trade Organization has some aspects of international maritime shipping within its purview. There are therefore many potential ‘sideways’ relationships among them. Yet, the memberships of the various international institutional arrangements differ significantly.

The Kyoto Protocol framework establishes the Production-based (PR) criterion (IEA, 2001) as the emissions responsibility allocation method. Greenhouse Gases emissions (GHG) are assigned depending on the country where they occur, regardless of the country where the consumption is done. This approach is controversial and is the point at which many emerging and large exporting countries base their refusal to sign the emissions reduction international agreements. Emerging countries argue that this is a result of the context where production and consumption decisions are increasingly separated in different parts of the world. Moreover, carbon leakage through international trade threats national reduction achievements at global level. One of the most popular scientific literature on alternative approaches proposes to shift responsibility to the consumer (Peters and Hertwich, 2008 or Davis et al., 2012) to be responsible for the emissions generated in the production of goods that are consumed within its borders, independently where the goods or services are produced. However, the consumer responsibility criterion (CR) has not managed to become part of international environmental legislation yet.

The global nature of climate change requires the establishment of allocation responsibility criteria that allow to involve more active participants of different countries in the process: governments, consumers, suppliers, workers, investors (Hoekstra and Wiedmann, 2014). Taking into account the presented context, achievements at global level. One of the most popular scientific literature on alternative approaches proposes to shift responsibility to the consumer (Peters and Hertwich, 2008 or Davis et al., 2012) in order to allocate the responsibility to the firms that take decisions, in many cases, of locating thousands of kilometers away from countries with environmental policies. This criterion assigns to those firms all the emissions embodied in linkage effects along the production chain. Taking into account the control criterion, the limits of enterprises’ responsibility is not determined by the country’s borders, this limit is given by the control that the parent company has on its subsidiaries firms and suppliers, regardless of their geographical location and where are citizens of the world that are consuming the goods produced by these enterprises.

Therefore it is necessary to find new frameworks that encourage more countries to sign emissions reduction international agreements and also that allow the responsibility transfer to companies and citizens as main actors in the mitigation of climate change. To shift the focus to the role of companies, instead of nation states, has some advantages as, for instance, not to deal with the problem of restricting responsibility to territory (PR) and government accountability. A new criterion based on the concept of production responsibility (PR) is proposed, previously presented in López et al. (2014), in order to allocate the responsibility to the firms that take decisions, in many cases, of locating thousands of kilometers away from countries with environmental policies. This criterion assigns to those firms all the emissions embodied in linkage effects along the production chain. Taking into account the control criterion, the limits of enterprises’ responsibility is not determined by the country’s borders, this limit is given by the control that the parent company has on its subsidiaries firms and suppliers, regardless of their geographical location and where are citizens of the world that are consuming the goods produced by these enterprises.

The Kyoto Protocol framework establishes the Production-based (PR) criterion (IEA, 2001) as the emissions responsibility allocation method. Greenhouse Gases emissions (GHG) are assigned depending on the country where they occur, regardless of the country where the consumption is done. This approach is controversial and is the point at which many emerging and large exporting countries base their refusal to sign the emissions reduction international agreements. Emerging countries argue that this is a result of the context where production and consumption decisions are increasingly separated in different parts of the world. Moreover, carbon leakage through international trade threatens national reduction achievements at global level. One of the most popular scientific literature on alternative approaches proposes to shift responsibility to the consumer (Peters and Hertwich, 2008 or Davis et al., 2012) in order to allocate the responsibility to the firms that take decisions, in many cases, of locating thousands of kilometers away from countries with environmental policies. This criterion assigns to those firms all the emissions embodied in linkage effects along the production chain. Taking into account the control criterion, the limits of enterprises’ responsibility is not determined by the country’s borders, this limit is given by the control that the parent company has on its subsidiaries firms and suppliers, regardless of their geographical location and where are citizens of the world that are consuming the goods produced by these enterprises.

Therefore it is necessary to find new frameworks that encourage more countries to sign emissions reduction international agreements and also that allow the responsibility transfer to companies and citizens as main actors in the mitigation of climate change. To shift the focus to the role of companies, instead of nation-states, has some advantages as, for instance, not to deal with the problem of restricting responsibility to territory (PR) and government accountability. A new criterion based on the concept of production responsibility (PR) is proposed, previously presented in López et al. (2014), in order to allocate the responsibility to the firms that take decisions, in many cases, of locating thousands of kilometers away from countries with environmental policies. This criterion assigns to those firms all the emissions embodied in linkage effects along the production chain. Taking into account the control criterion, the limits of enterprises’ responsibility is not determined by the country’s borders, this limit is given by the control that the parent company has on its subsidiaries firms and suppliers, regardless of their geographical location and where are citizens of the world that are consuming the goods produced by these enterprises.

Furthermore, there is also the need to find new frameworks that allow transferring the responsibility of emissions reduction to the companies. This is particularly relevant in the context of the international maritime shipping sector, where the emissions from international shipping, despite being a significant source of greenhouse gas emissions, are currently subject to limited regulation.

P-4409-05
Global emissions chains and multinational enterprises: measuring responsibilities following the control criterion
MA. Cadarso (1); L. Lopez (2); J. Zafriilla (1); G. Arce (3)
(1) University of Castilla – La Mancha, Economic Analysis and Finance, Albacete, Spain; (2) Universidad de Castilla La Mancha, Albacete, Spain; (3) University of Castilla – La Mancha, Albacete, Spain

The Kyoto Protocol framework establishes the Production-based (PR) criterion (IEA, 2001) as the emissions responsibility allocation method. Greenhouse Gases emissions (GHG) are assigned depending on the country where they occur, regardless of the country where the consumption is done. This approach is controversial and is the point at which many emerging and large exporting countries base their refusal to sign the emissions reduction international agreements. Emerging countries argue that this is a result of the context where production and consumption decisions are increasingly separated in different parts of the world. Moreover, carbon leakage through international trade threatens national reduction achievements at global level. One of the most popular scientific literature on alternative approaches proposes to shift responsibility to the consumer (Peters and Hertwich, 2008 or Davis et al., 2012) in order to allocate the responsibility to the firms that take decisions, in many cases, of locating thousands of kilometers away from countries with environmental policies. This criterion assigns to those firms all the emissions embodied in linkage effects along the production chain. Taking into account the control criterion, the limits of enterprises’ responsibility is not determined by the country’s borders, this limit is given by the control that the parent company has on its subsidiaries firms and suppliers, regardless of their geographical location and where are citizens of the world that are consuming the goods produced by these enterprises.

Therefore it is necessary to find new frameworks that encourage more countries to sign emissions reduction international agreements and also that allow the responsibility transfer to companies and citizens as main actors in the mitigation of climate change. To shift the focus to the role of companies, instead of nation-states, has some advantages as, for instance, not to deal with the problem of restricting responsibility to territory (PR) and government accountability. A new criterion based on the concept of production responsibility (PR) is proposed, previously presented in López et al. (2014), in order to allocate the responsibility to the firms that take decisions, in many cases, of locating thousands of kilometers away from countries with environmental policies. This criterion assigns to those firms all the emissions embodied in linkage effects along the production chain. Taking into account the control criterion, the limits of enterprises’ responsibility is not determined by the country’s borders, this limit is given by the control that the parent company has on its subsidiaries firms and suppliers, regardless of their geographical location and where are citizens of the world that are consuming the goods produced by these enterprises.
management in environmental terms of the global value chains by the companies.

The aim of this paper is to calculate a control–based criterion for China in a multiregional input–output context (MRIO), which allows the assessing of the impact of international trade considering all the emissions associated with the entire global value chains. The Chinese choice is due to foreign enterprises operating and exporting in China account for 54% (Peenstra et al., 2013) and have a strong potential influence over the global production chains with respect to technology and emission intensities (Skelton, 2013). Estimations will be done using the World Input–Output Database (WIOD) that provides information about 41 regions with a sectoral disaggregation of 35 industries. These data will be combined with information about multinationals operating in China for the year 2009.

P-4409-06

Preventive communication and risk preventive policy in Guadeloupe

V. Charneau (1)

(1) Université des Antilles, Science–Politique, Pointe–à–Pitre, France

Located in an area geographically and geologically unstable, the Caribbean basin, is regularly attacked by natural hazards. Thus, earthquakes, hurricanes, volcanic eruptions and all their consequences are an integral part of the lives of various people and institutions in the Caribbean area. The threats that people must face and that institutions must support the policies of prevention and risk management. Since the recent decades, the focus was on natural science, it is party to the increase in the temperature of which one of its consequences is the increase in the frequency and magnitude of natural hazards.

The Guadeloupe is part of the French Departments of America, it has implemented the risk of public policies, among them measures relating to the dissemination of preventive information. Because, recently, the effectiveness of natural risk prevention and management plans based on the citizens’ information procedures. But public policy risk through natural risk prevention plan does not clearly define the information broadcasts measures. Thus it is clear will to respond to threats that raise natural hazards and of involving people in the management of these, the association «consensus–communication» under the Risk Prevention Plan. Then, reaching to emerge, communication as a «means to mobilize» in the context of preventive actions, and also prevent the risk from climate upheaval.

This study aims to analyze public policies for risk management and dissemination process of preventive information. To do this, it will make a brief review of the history and contributions of the state of the scientific literature in the humanities and social sciences, the concept of risk, highlighting briefly science developments information, communication, and finally, it will analyze synthetically the natural risk prevention plan for the city of Petit–Bourg in Guadeloupe, especially for highlighting the organization of public consultation required by the plan.

P-4409-07

Climate Change and Collective Action: Lessons from Elinor Ostrom and the Bloomington School of Political Economy

D. Cole (1)

(1) Indiana University, School of Law and School of Public & Environmental Affairs, Bloomington, IN, United States of America

Climate change has been largely mischaracterized as a “public good” subject to a Prisoners’ Dilemma game, where it is in the individual interest of each country to continue emitting greenhouse gases, even though it is the global interest for each country to curtail its emissions. Given this characterization, the collective action problem posed by anthropogenic climate change is practically insurmountable.

But climate change is, in fact, a different type of good and subject to a different kind of game to which a cooperative solution is available (though not guaranteed). Whereas prior to the Industrial Revolution it made sense to think of the climate as a “public good” (in its very existence the climate change problem indicates that the climate is now more in the nature of a “common–pool resource” (CPR) with characteristics similar to many situations Elinor Ostrom studied during her storied career, albeit at a much larger scale. As a “common–pool resource” (CPR) the global climate is subject to the same kinds of analytical frameworks, theories, and methods that Ostrom and her colleagues in the Workshop in Political Theory and Policy Analysis at Indiana University have used over the past 45 years to study other types of CPRs.

Like virtually all other CPRs, the collective action problem posed by climate change really is not in the nature of a Prisoners’ Dilemma, but more like an “Assurance Game,” as originally defined by Amartya Sen. In contrast to a Prisoners’ Dilemma, Assurances are based on cooperative and non-cooperative equilibria. Which equilibrium solution is reached depends largely on the level of reciprocal trust among the players. The higher the level of mutual trust, the higher the payoffs from cooperation, relative to non–cooperation.

In a variety of experimental and field settings, Ostrom and her colleagues found that, under the right conditions, mutual trust can be fostered over time, raising the perceived returns to cooperation. Among the conditions they found that fostered trust are frequent opportunities for communication and interaction. Specifically, Ostrom found that increased communication (1) facilitates development of socially optimal strategies; (2) allows for exchanges of promises; (3) increases mutual trust; (4) adds value to payoffs; (5) reinforces shared norms; and (6) promotes the development of shared or group identities. However, the building of mutual trust does not depend on communication alone but also on the ability to observe and verify that others are acting in a trustworthy fashion. Thus, monitoring and accountability are crucial parts of the puzzle for successful collective action to resolve any kind of CPR problem, including climate change. Trust is not a matter of blind faith; verifiability is part and parcel of trust.

Beyond culling lessons from Ostrom’s large corpus of empirical, theoretical, and analytical studies, I will exemplify those lessons by reference to recent trust-building, cooperative ventures on climate policy between the US and China. The “US–China Climate Change Working Group” already has achieved substantial positive outcomes for climate policy, and more quickly than anyone had imagined possible. Meanwhile, cooperation is ongoing at various levels of governance, including the local government level and even in private governance. Thus, climate negotiations are becoming increasingly “polycentric,” as Vincent and Elinor Ostrom defined that term.

Far from being a threat to global negotiations under the UNFCCC and its Protocols, these lower-level negotiations should be perceived as activities in furtherance of goals established in global–level agreements. They are the kinds of interactions that are in fact necessary to build, over time, the kind of mutual trust that is required to make further progress on climate change mitigation at the global level. The increasing bilateral and multilateral communications and agreements we have been witnessing do not guarantee a cooperative outcome to the Assurance Game of climate change, but without them a non-cooperative outcome is almost guaranteed.

P-4409-08

Explaining climate bargaining strategies of developing countries

V. Costantini (1); G. Sforna (1); M. Zoli (2)

(1) Roma Tre University, Department of Economics, Rome, Italy; (2) University Rome Tor Vergata, Rome, Italy

Although the efforts made during the last COPs, Parties are still far from achieving an agreement for the implementation of a new regime. As demonstrated by the debate about the interpretation of the Common But Differentiated Responsibilities principle, the growing role played by developing countries in negotiations is on the one hand, to claim their rights. For this reason, attention should be paid to the composition of the negotiating coalitions of developing countries. By applying a cluster analysis, this paper aims at investigating the role played by the heterogeneity in structural features of
Renewable energy: past trends and future growth in 2 degrees scenarios

W. Crijns-Graus (1)
(1) Copernicus Institute of Sustainable Development, Department of innovation, environmental and energy sciences, University of Utrecht, Netherlands

Many studies agree that a transition to a sustainable energy supply is needed in order to safeguard the supply of energy for future generation and abate greenhouse gas emissions. Limiting the average global surface temperature increase to 2°C, commonly referred to as the 2 degrees target, is widely accepted by scientists and policy makers as the solution to climate change. The implementation of this target, however, is still a challenge due to a large number of vulnerability sources to climate change and the economic development level.

It is worthwhile noting that these are all crucial variables for climate change negotiations and might help better understanding the reasons behind bargaining positions of COPs. As will be demonstrated, as well as the strategic impacts of a potential climate agreement on heterogeneous interests.

The third cluster gathers the largest number of countries, grouping together the Least Developed Countries in Africa and South East Asia. This group is characterized by a high vulnerability degree to climate change and a low responsibility in GHG emissions. This explains why LDCs ask for a stringent agreement including emerging economies. In terms of climate governance, this group might influence the final agreement in the direction of a challenging mitigation action but they also need a strong financial support for recovering climate damages. This particular double interest position might reduce their bargaining position in the climate negotiation. However, they will not contribute to mitigation costs and they will benefit the most from international assistance.

Conversely, the fourth cluster reveals that there are countries whose structural features put them in a contrasting position with respect to any potential climate agreement outcome. More specifically, these are poor and vulnerable countries with a strong economic dependency from fossil fuels export. This means that if a challenging mitigation action will be settled, they will be negatively impacted. This can lead these countries to advocate different interests, joining alternative bargaining coalitions (LCDs as well as fossil fuel producers) during different climate negotiations, increasing the uptake of renewable energy. Only a few countries managed to increase the share of renewable energy in their fuel mix. Most notably Germany demonstrated an effective increase in renewable energy from 3% in 2001 to 11% in 2012, followed by a high overall growth rate for renewable energy of 11%/yr and a decrease in primary energy use of 0.7%/yr. Energy and climate policies in EU28 overall showed an effect in increasing the share of renewable energy from 9% in 2001 to 11% in 2012 with slightly decreasing energy use. China and India showed decreasing shares of renewable energy due to a high growth rate for total energy use combined with more moderate overall growth rates of renewable energy.

The overall increase in renewable energy amounted to 2.2%/yr in the period 1971–2012 and 2.6%/yr in the period 2000–2012. In order to be consistent with a 2 degrees pathway these growth rates would need to increase to 3–5%/yr. Biomass is at the moment the largest source of renewable energy used globally, equivalent to 10% of total primary energy use in 2012, followed by hydro power responsible for 2%. A transition of energy supply in order to help achieve a 2 degrees target would not only require a strong growth of renewable energy in absolute and relative sense, but also a strong shift to other renewable energy sources than biomass and hydro. Especially high growth would be required for wind, solar and geothermal in the order of 10%/yr. This would lead to a change in the mix of renewable energy used, with a much higher share of variable renewable energy sources (VRES). Overall wind was the most popular energy source increase by as much as a factor of 30–60 in 2050, in comparison to 2012 (from 3 EJ to 58–155 EJ). The share of renewable energy would be in the range of 40–80% of energy use, with the share of wind and solar amounting to 25–54% of renewable energy use.

However most notable from the assessment of future needed growth rates is, the strong difference in the required development of energy use, compared to past trends. For decades primary energy use needs to consistently decrease by 0.1–0.5%/yr for OECD regions. A stagnation has occurred in many non-OECD regions during a time of recession. This would therefore require a breach from past trends. But especially for non OECD regions and China has the need to increase growth rates for energy use in the period 2000–2012 range from 1.5%/yr to 5.5%/yr and should decrease to be within the range of 0.2%/yr to 0.9%/yr. Therefore, a main challenge, besides increasing the uptake of renewable energy, would lie in the decrease of energy use growth rates in non-OECD countries.

P-4409-09

P-4409-10

Routes to an ambitious climate agreement in 2015

C. Perthusi (1); PA. Jouvet (2)
(1) Climate Economics Chair, PARIS, France; (2) Paris Ouest Nanterre University, Economics, Nanterre, France
As shown by the collective action for the protection of the ozone layer, the success of multilateral agreements rests on three pillars: strong political commitment, an independent and rigorous monitoring system, and economic instruments that transmit the right incentives. For it to be a success, the 2015 Paris climate conference will need to make progress on each of these three pillars. The Climate Economics Chair has focussed its research efforts on the pillar of economic instruments.

- The Fifth Assessment Report of the IPCC states unequivocally that from 2020 all major emitters of greenhouse gas emissions must participate in the global effort to reduce emissions and limit average warming to no more than 2°C.
- In order to drastically curb emission trajectories, global carbon pricing should be rapidly introduced, so as to put pressure on governments to act cooperatively and to encourage economic actors to reduce emissions at the lowest cost.
- To encourage governments to reach a global agreement, a bonus–malus carbon pricing system, calculated on the basis of average emissions per capita, could be introduced at a rate of $7–9 per tonne of CO₂ equivalent from 2020.
- The most realistic way of introducing an international carbon price into the global economy is to lay the foundation, between 2015 and 2020, of a transcontinental carbon market, based on prototypes developed in Europe, China and the United States.
- The introduction of double carbon pricing would be subject to the principle of “common but differentiated responsibilities”, aimed at reconciling joint action on climate change and the priority of access to development.

**P-4409-12**

**Does fragmentation pay? Multiple international environmental agreements with asymmetric countries**

A. Hagen (1); K. Eisenack (1)
(1) Carl von Ossietzky Universität Oldenburg, Oldenburg, Germany

While the negative effects of greenhouse gas emissions and the global climate change are relatively well acknowledged amongst scientists, solutions for what should and could be done to tackle these problems are less agreed upon. Spillovers and the absence of clear property rights make it difficult to reach effective cooperation through international environmental agreements (IEAs). In light of the slow progress in international climate negotiations, the idea of climate clubs is getting increasing attention. The aim of negotiating one single universal agreement is identified as one primary obstacle to a global treaty within the United Nations Framework Convention on Climate Change (UNFCCC).

We investigate whether global cooperation for emission abatement can be improved if asymmetric countries can sign multiple parallel environmental agreements. In a two-stage game, countries first choose whether they sign one agreement, or to be a non-signatory. In the second stage, each country acts as a unitary actor in a non-cooperative Nash game between the coalitions and the non-signatories. We compare emissions abatement and coalition stability in the multiple IEAs case with the standard case where not more than one IEA is possible. After solving the model for the case of constant marginal benefits from abatement and constant marginal costs of abatement with two agreements we relax our assumptions and allow for multiple coalitions with multiple types of asymmetric countries. We then analyze the effect of multiple coalitions for the case of increasing marginal costs of abatement as well as for decreasing marginal costs of abatement. The general result is that climate clubs are at least not detrimental to global cooperation. This paper already shows how different assumptions lead to different effects of country clubs. It is thus a consequent stepping stone towards a more detailed understanding of the determinants for beneficial or detrimental effects of climate clubs. In any case, it has to be concluded that the idea of climate clubs enhancing global climate protection has to be taken with precaution, but that it clearly deserves more analytical attention.

**P-4409-11**

**How to increase mitigation? Some lessons from the Montreal Protocol on the protection of the ozone**

J. De Sepibus (1)
(1) University of Bern, Law Faculty, Bern, Switzerland

The necessity to increase mitigation efforts while addressing carbon leakage and generating climate finance, represents one of the most daunting challenges of the future climate regime. We argue that these goals could be achieved through the adoption of an agreement (hereafter the “agreement”) by a group of countries that set ambitious mitigation targets for specific sectors and impose border tax adjustments on commodities from non-parties that do not meet comparable carbon standards. The institutional architecture of such an agreement would be construed along the lines of the Montreal Protocol on the protection of the ozone layer, i.e. it would contain rules that assure that non-participants loose more from being outside the agreement than they gain. Moreover, to induce countries to participate, carrots would be offered in the guise of financial and technical assistance, based on the principle of common but differentiated responsibilities.

As the Montreal Protocol the new Agreement would a) provide for majority voting for the adoption of amendments b) have effective compliance mechanisms and c) rules ensuring due process of law. To ensure the comparability of mitigation efforts the Parties would inter alia develop common rules for sector data requirements, measurement, reporting and verification practices, methodologies underlying the calculation of the level of BCA from non-parties.

**P-4409-13**

**Adapting, transforming, strategising: A conceptual capacities framework for transsilence climate governance**

K. Hölscher (1); N. Frantzeskaki (2); D. Loorbach (3)
(1) DRIFT (Dutch Research Institute for Transitions), Rotterdam, Netherlands; (2) Erasmus University, Rotterdam, Netherlands; (3) Dutch Research Institute for Transitions, Rotterdam, Netherlands

Climate change will profoundly shape the future of human societies (IPCC 2014, Smith et al. 2011). Addressing climate change requires sustainability transitions of deeply entrenched drivers of climate change (Meadowcroft 2009). Uncertainties, the likelihood of surprise events, non-linear and extreme impacts resulting from climate change demand managing social–ecological resilience across scales and times (Pelling 2011, Nelson 2011, Wise et al. 2014, Jäger et al. 2012). From the integration of transdisciplinary resilience scholarships, we developed a conceptual framework for dealing with high uncertainty contexts and navigating through high level of complexity found in these contexts (Hölscher et al. 2014). The developed
Co-producing climate change responses: incorporating practitioner knowledge in the IPCC Process

C. Howarth (1)

(1) Global Sustainability Institute, Anglia Ruskin University, Cambridge, United Kingdom

The process and flow of information and expertise on climate change is complex. The multiple interfaces existing between scientists, policymakers and practitioners are far from well understood to adequately assess and refine strategies for climate adaptation. The gathering of evidence for the Intergovernmental Panel on Climate Change (IPCC) reports is an exercise conducted primarily by the scientific and political communities, and does not take into account the expertise, knowledge and work on the ground. Although increasing efforts are being made to improve the science–policy interface, the disconnection between science and practitioners remains a key barrier to progress in climate change adaptation.

The latest findings from Working Group 2 on Impacts and Adaptation of Climate Change remain largely inaccessible to practitioners and do not fully incorporate their ongoing work on climate change issues. This is mainly the result of the IPCC process being highly academic–oriented and based on the peer-review mechanism with long lag times, and communication challenges, including different language and cultural interpretations. Building on the IPCC’s recent review of how to make its reports more accessible going forward, this research assesses the extent to which models of co-production can capture the depth and breadth of the practitioner community’s work and effectively incorporate this into the IPCC process. For example the practitioner community is starting to adopt the term ‘resilience’ instead of adaptation.

The premise for adopting models of co-production acknowledges that knowledge from different stakeholders (e.g. academics, policy, media, NGO, business, public, and practitioners) can be seen as ‘useful frames for capturing different approaches to knowledge production’. Such a process would ensure that future IPCC reports are more up-to-date, robust and complete in their analysis and that the climate change resilience solutions proposed incorporate the most practically viable research.

Through a series of workshops and interviews with academics, policy officials and practitioners in the United Kingdom this research focuses on the following three questions:

1. Can a co-production process facilitate the incorporation of practitioner expertise in IPCC reports?
2. What are the limits and opportunities from (i) adopting such an approach and (ii) incorporating practitioner based evidence?
3. How can the role of those involved in this process ensure better communication of the IPCC and wider climate messages and better co-design climate resilience?

This presentation will outline preliminary findings from these workshops and interviews and will provide valuable insights into how a co-production approach and the incorporation of practitioner based evidence could improve the production, dissemination and use of IPCC WG2 reports going forward in designing strategies for climate resilience.
Even without internationally concerted action on climate change mitigation, there are important incentives for countries to put a price on their domestic emissions, including public finance considerations, internalizing the climate impacts of their own emissions, and co-benefits, such as reduced air pollution and energy security. While these arguments have been mostly discussed in separate strands of literature, this article carries out a synthesis that exemplifies how policies to put a price on emissions can be incorporated in a multi-objective framework. Despite considerable uncertainty, empirical evidence suggests that different countries may face quite different incentives for emission pricing. For instance, avoided climate damages and health co-benefits of reduced air pollution provide the main motivation for emission pricing in China, while for the US generating public revenue dominates and for the EU all three motivations are of intermediate importance. We finally argue that such unilateral incentives could form the basis for incremental progress in international climate negotiations toward a realistic climate treaty based on national interest and differentiated emission pricing and describe how such an agreement could be put into practice.

P-4409-16
Adaptation of Legal Framework to Combat Climate Change in India

KN. Joshi (1)
(1) Institute of Institute of Development Studies, Natural Resources Management and Environment (Remote Sensing), Jaipur, Rajasthan, India

India is facing challenges of sustaining rapid economic growth while dealing with the global threat of climate change. The threat mainly is from increasing greenhouse gas due to industrialization, automobile, intensive agriculture, reduction in green cover and high consumption lifestyle. It poses a serious threat to the natural resource base of the country. India may face a major threat because of the projected climate change. Recognizing this fact and knowing that climate change is a global challenge, India has entered actively in multilateral negotiations in UN framework on global conventions on climate change, in positive, constructive and forward-looking manner.

India signed the United Nations Framework Convention on Climate change (UNFCCC) on June 10, 1992 and ratified it on November 1, 1993. It ratified the Kyoto Protocol on August 26, 2002, with the objective to establish an effective, cooperative and equitable global approach based on the principal of common but differentiated responsibility, enshrined in the UN framework.

India is one of the leading developing countries in so far as having incorporated into its Constitution the specific provisions for environmental protection in year 1950. Article 48A of the Constitution of India provides that the State shall endeavor to protect and improve the environment and to safeguard the forests and wild life of the country. Similarly, Article 51A (g) makes it obligatory for every citizen of India, 'to protect and improve the natural environment including forests, lakes, rivers and wild life, and to have compassion for living creatures.' Despite the fact that India’s contributions to greenhouse gas emissions are very small, the Government of India has taken many measures to improve the situation in this regard. India has initiated several climate-friendly measures, particularly in the area of renewable energy. It has one of the most active renewable energy programs besides having a dedicated Ministry for non-conventional energy sources in general and mitigation of greenhouse gases in particular.

This paper is an attempt to provide an overview of the legal framework for combating climate change in India and to examine the existing environmental law and policies which can encourage emissions reductions. It reviews existing national legislation, relevant overarching policies in the environmental field so as to reduce their impact specifically on climate change.
• Are there any risks of linking climate change to security such as the ones which assumes that framing climate change as a security issue may overshadow important social and environmental concerns and sending ironically fear-based and disturbing messages to relevant decision making processes?

• To what extent the mainstreaming of climate security as a priority in the agenda of climate diplomacy can narrow the scope and scale of action internationally and domestically?

• What kind of adjustments to be undertaken on all levels to make the ‘climate security approach’ relevant and effective in terms of climate governance?

P-4409-18

Critical Mass Governance: How Unilateral Climate Actions Create Global Impacts

L. Kemp (1)

(1) Australian National University, Fenner School of Environment and Society, Canberra, ACT, France

The current practice of UN based climate multilateralism under the UN Framework Convention on Climate Change (UNFCCC) focuses upon broad consensus based legal treaties that cover a large number of issues. It is an approach that is creating diminishing returns over time. Despite this, it appears that the next climate agreement to be decided at the 21st Conference of the Parties (COP21) to the UNFCCC, will also prioritise the construction of a treaty with ‘universal participation’. This paper argues that a switch towards smaller treaties which attempt to worry over with the thought of the still more viable approach forward. By drawing together ideas from a range of fields such as ‘The Theory of Critical Mass’ from sociology, ‘Bandwagoning’ and ‘Norm Cascades’ from international relations, and bilateral proposals for both the climate and trade regimes, and practical examples from the EU and Kyoto Protocol, a theory of “Critical Mass Multilateralism” for climate change is developed. These disparate ideas and examples are brought together under the notion that a single action can cause further effects which amplify over time. Accordingly, there is both a theoretical foundation and precedence for the mitigation actions of a few states to spread to others. This conceptual framework is then applied to case studies of both the Convention on Biological Diversity, the Kyoto Protocol and Montreal Protocol. The Theory of Critical Mass Multilateralism would suggest the theoretical climate agreement should focus on facilitating and linking strong unilateral and plurilateral actions, instead of seeking a universal and consensual deal with the ratification of all major players including the US. The key problem is that a major global emitter, should, and most likely will, be in a number of smaller, more focused treaties, regardless of whether the Paris negotiations succeed or fail. The theory claims that a future climate treaty is not to address free-riding and carbon leakage concerns, but to enable a critical mass of action that will generate the necessary feedbacks in terms of market prices, norms and political will. Addressing climate change internationally is not a matter for a global deal, but simply a critical mass of progressive actors.

P-4409-19

Leadership in Climate Change Mitigation: Consequences and Incentives

M. Kornek (1); K. Lessmann (1); M. Pahle (2); G. Schwerhoff (2)

(1) Potsdam Institute for Climate Impact Research, Sustainable Solutions, Potsdam, Germany; (2) Potsdam Institute for Climate Impact Research (PIK), Potsdam, Germany

So far, the UNFCCC climate negotiations have not delivered a decrease in global greenhouse gas emissions. In contrast to this lack of ambition at the global level, several local, national, and regional initiatives have emerged in the past that pursue more ambitious unilateral abatement targets – for example the European Union, California – in a way that initiatives can be expected to emerge in the future. This comes as a surprise in view of classical theory, which suggests that ambitious unilateral provision of a global public good is never beneficial for the actor performing the abatement. Instead, global emissions tend to increase as a consequence of unilateral action, reducing the effectiveness of the abatement. This paper argues that ambitions need to be reassessed in light of the potential multiplier effects that can arise. Taking all negative and positive reactions into account, leadership in ambitious abatement efforts could pay off for some actors, at least in expectation. The ongoing debate on the effectiveness of climate leadership in greenhouse gas abatement among the academic, the political as well as the public sphere emphasizes the importance of a clear and comprehensive understanding of the net consequence of unilateral action.

We analyze all major channels through which countries are influenced by unilateral abatement of a climate leader and derive functions for the resulting reaction in emissions. Carbon leakage effects, for example, are included by considering that: (i) countries increase their emissions because more of the public good is provided, which decreases the demand for the individual production of the public good of all other countries; (ii) emission intensive energy carriers which decreases their global price and leads to increasing demand in other countries and hence higher emission, and (iii) emission intensive production relocates from the leading country to countries with less stringent policies and hence emissions increase abroad. The negative carbon leakage effects are counterbalanced by positive reaction functions, in which countries decrease their emissions in response to unilateral abatement. First, the leading country will develop new technologies to decrease its emissions in the face of ambitious abatement targets. Through technological spill-overs to other countries global emissions decrease even without additional emission policies by other countries. Second, a leading country decreases abatement cost unambiguously by reducing the costs of abatement. In Risk–averse countries will in turn increase their emissions reduction targets after learning about the costs of the leader. Third, through the process of policy emulation, policies diffuse to and are adopted by other countries because of their normative and socially constructed properties instead of their objective characteristics. Fourth, countries may have an incentive to reciprocate to the ambitious actions of a leader. Lastly, a leading country may signal to other countries that it is implementing the cooperative effort, inducing other countries to adopt an analogous effort.

The common modeling framework for each of the above described effects enables us to identify the critical parameters that shape the overall reaction to unilateral emission abatement and allows us to distinguish losses for far the reactions differ among following countries and for the leading actor. The analysis suggests that effective leadership in climate action is facilitated by (i) high visibility and credibility of the actions of the potential leader, (ii) a strong international connectedness, both in economic and political terms, (iii) a leader whose emitting sectors are similar to those of the main global emitters, and (iv) the capacity and infrastructure to develop technology effectively.

However, due to the number of channels of interaction between leader and others, each of which is only imperfectly known, we expect the actual reactions of countries without ambitious targets to be highly uncertain. Well know that despite this, leadership may be profitable (in expectation) for the leading country if it is establishing high value for the public good or exhibits little risk aversion. Our analysis can thus produce rationale for observed ambitious abatement of current climate policy leaders and their future abatement or for future leaders in the abatement of greenhouse gases.

P-4409-20

Soft and/or Hard - What Set-Up for a Future Governance System to Implement a New Climate Deal?

M. Kuhner (1)

(1) Maastricht University, Political Science, Maastricht, Netherlands

A new climate regime is not only about the nature, reach and ambition of such an international agreement, but also about effective arrangements to ensure its implementation. This presentation will analyse the existing governance framework for climate governance, looking in particular at the UNFCCC and the Momentum for Change initiative.
system under the Kyoto Protocol (KP). By shedding light on how implementation of the emission reduction targets under that regime have been monitored so far, the aim is to understand what elements of the governance mechanism were useful for fostering compliance and why. In particular, the role of facilitative elements is assessed. Building on existing literature on reasons for non-compliance/ lack of implementation and ways to best achieve compliance/implementations, advantages and disadvantages of facilitative elements and compliance of states is of high relevance, especially when discussing a new governance system for climate compliance/implementation.

The presentation will start by outlining the current compliance system under the KP, focusing in particular on the interplay between facilitative and enforcement elements. Lessons learnt will be developed by drawing on empirical findings of usefulness perceptions held by different stakeholders, in particular of the ‘soft’ components of cooperation. These findings will be used to develop different scenarios for a future governance system. The talk will finish with an outlook of plausible and desirable governance set-ups post-2020.

P-4409-21

The Stability and Effectiveness of Climate Coalitions: A Comparative Analysis of Multiple Integrated Assessment Models

K. Lessmann (1); U. Kornek (2); V. Bosetti (3); R. Dellink (4); J. Emmerling (5); J. Eckmans (6); M. Nagashima (7); Z. Yang (8)

(1) Potsdam Institute for Climate Impact Research, Potsdam, Germany; (2) Potsdam Institute for Climate Impact Research, Sustainable Solutions, Potsdam, Germany; (3) Fondazione Eni Enrico Mattei, Milano, Italy; (4) OECD, Paris, France; (5) FEEM, Milano, Italy; (6) KU Leuven, Center for economics and corporate sustainability (cedon), Brussels, Belgium; (7) Research Institute of Innovative Technology for the Earth (RITE), Kyoto, Japan; (8) State University of New York at Binghamton, Department of economics, Binghamton, NY, United States of America

International climate policy suffers from the adverse structure of public good provision, and it is well known that non-cooperative behavior results in under-provision of such goods. How much a climate coalition improves upon this dilemma depends on the costs and benefits of the individual nations. It is particularly dependent on their heterogeneity and whether nations can compensate the existence of transfer schemes. In this study, we investigate coalition formation with real-world heterogeneity and various transfer schemes for the first time using an ensemble of five numerical models.

Numerical models give particularly valuable insights beyond that of their analytical counterparts, where the analysis depends on regional heterogeneity in costs and benefits, quantitative estimates, or detailed representations of reaction functions. The models in this study are an extension of their analytical approach and the data sources used for calibration, representing a range of estimates for the costs and benefits of real-world regions and their dynamics. We make these differences in cost and benefit assumption comparable through two new indicators measuring the abatement potential and climate change damages for key countries and world regions. What we find is that the five models frequently differ in the assumed cost and benefit assumptions of specific countries or regions, with stronger disagreement about regional damages and better agreement about mitigation costs, which mirrors the large uncertainty in our knowledge about climate change impacts.

Consequently, the models do not necessarily agree in their assessment of the stability of specific coalitions. Remarkably, however, the models are very consistent in translating the cost/benefit information revealed by the indicators into whether or not a region supports a climate agreement, i.e. coalitions with similarly characterized signatories are stable in all models. Thus, the reason why a specific coalition is found to be stable only in a subset of models is traced back to the cost/benefit assumptions.

We also assess the potential of transfers that redistribute the surplus of cooperation to foster the stability of climate coalitions. In contrast to much of the existing analytical game theoretical literature, we find substantial scope for self-enforcing climate change strategies, i.e. the existence of the abatement and welfare gap between complete absence of cooperation and full cooperation. This more positive message follows from the use of appropriate transfer schemes that do not rely on free riding incentives. By comparison, transfers that specifically take the incentive to sign a climate agreement into account frequently differ from the transfer implicit in common normative and pragmatic burden sharing schemes, which are found to be comparatively high in volume and often to transfer payments in the wrong direction.

P-4409-22

Using the Theory of Planned Behaviour to Understand and Promote Stakeholder Engagement in Local Adaptation to Climate Change

S. Luis et al.; M. Lima (1); A. Rosseta-Palma (2); N. Rodrigues (3); F. Alves (3); L. Soesa (3); F. Pereira (3); C. Parrod (4); V. Jolivet (4); S. Poulos (5); G. Alexandrakis (6); T. Paramana (5)

(1) Instituto Universitário de Lisboa (ISCTE – IUL), CIS – IUL, Lisbon, Portugal; (2) Instituto Universitário de Lisboa (ISCTE – IUL), BRU – IUL, Lisbon, Portugal; (3) ISEGI (Institute of Applied Mathematics (UA), CESAM, Lisbon, Portugal; (4) Acteon, Colmar, France; (5) National and Kapodistrian University of Athens, Faculty of Geology and Geoenvironment, Laboratory of physical geography, Athens, Greece; (6) Institute of Applied Mathematics, Computational Mathematics, Foundation of Research and Technology, Hellas, Greece

Most policy documents on climate change highlight the need for stakeholder engagement on policy making regarding local adaptation to climate change. There appear to different rationales for this. Engagement is promoted as way to achieve greater acceptance of policies and environmental awareness and to improve quality in decision making. In parallel, engagement ensures democratic legitimacy because citizens have a right to be included in climate-change related decisions that affect their lives (Lee et al., 2013). However, the levels of engagement in climate change issues are not typically high (e.g., Few, Brown, & Tompkins, 2006) and more research is needed to learn how engagement can be increased and improved.

The theory of planned behaviour (Ajzen, 1985) can be used to understand and promote engagement in adaptation to climate change. Even if several theories explain human behaviour and decision-making, this is one of most influential and powerful, both for its ability to predict and explain behaviour and for its contribution towards framing and evaluating behaviour change interventions (Nosek et al., 2010). Previous studies have used it to understand climate change mitigation (e.g., Tikir & Lehmann, 2011). In this study, we explored its usefulness to understand stakeholder engagement in adaptation to climate change. The theory of planned behaviour is a useful conceptual framework that incorporates central concepts in the social and behaviour sciences. It postulates that behaviour is motivated by situation-specific beliefs about the likely consequences of the behaviour (behavioural beliefs), beliefs about the control of the outcome (control beliefs), and beliefs about the presence of factors that may influence performance of the behaviour (control beliefs). Behavioural beliefs create a favourable or unfavourable evaluation of the behaviour (the value of the behaviour); normative beliefs produce the perceived social pressure regarding the behaviour (subjective norm); and control beliefs create the perceived ability to perform the behaviour (perceived behavioural control). Behavioural intention, which is the immediate antecedent of behaviour, is formed based on the attitude towards the behaviour, subjective norm, and perception of behavioural control.

Based on previous research and on a literature review, we explored different types of behavioural beliefs (e.g., costs and benefits of adaptation, attitudes towards public participation), normative beliefs (descriptive and
injunctive) and control beliefs (e.g., information on climate change and public participation, stakeholder salience). Stakeholders from different case studies in the Mediterranean were surveyed (e.g., policymakers, elected officers, researchers). Results show that the behavioural intention to engage in the process of planning adaptation to climate change was significantly predicted by particular variables of the theory of planned behaviour, depending on the characteristics of the case studies. Furthermore, descriptive results indicate which specific beliefs should be stressed in future interventions to promote stakeholder engagement.

This work has received funds from the ADAPT-MED project (CIRCLE2-MED).

References


P-4409-23

Framing a post-Kyoto Climate Accord
J. Mathews (1)

(1) Macquarie University, Macquarie Graduate School of Management, Sydney NSW, France

The forthcoming Paris conference of the parties under the UNFCCC, to be staged in November 2015, is tasked with developing a global climate agreement focused on carbon reduction, as successor to the Kyoto Protocol. If this “Paris Protocol” (if such is to be its name) is to be effective it will need to go beyond a list of countries committing to make reductions in carbon emissions, to incorporate measures needed to address the promotion of green industry and its diffusion around the world. A putative Part II to the Paris Protocol could be addressed to the WTO, and list green products or processes that are agreed will lead to reduced carbon emissions – and as such provide countries with “justification” for no longer adhering to the rule of Kyoto for a designated period. It is argued that such a bold step is needed to reduce the severity and frequency of trade disputes over green industrial policies and clear the way for the carbon reductions anticipated to come to fruition.

P-4409-24

Who governs local climate adaptation? A comparative analysis of governance arrangements in urban areas
H. Mees, (1)

(1) Copernicus Institute of Sustainable Development, Utrecht university, Utrecht, Netherlands

The allocation of responsibilities between public and private actors has become a key urban governance issue for adaptation to the impacts of climate change. While this issue has been explored conceptually to some extent, empirical studies are scarce and have not yet been performed in a systematic manner. This paper addresses the research question of who governs urban climate adaptation, by offering a synthesis of three empirical studies in urban climate adaptation governance arrangements. In-depth interviews and in-depth surveys are conducted and compared. The study contains an in-depth comparative case–study analysis of arrangements for adaptation measures in frontrunner cities in Europe and North America: 1) green roofs for storm-water retention purposes, 2) adaptive flood risk measures for water safety purposes, and 3) a selection of measures for heat stress prevention. In total, 20 governance arrangements were analysed and compared based on data derived from over 100 policy documents; from 97 in-depth interviews; and from two multi–stakeholder workshops. The meta-analysis offers insights into emerging patterns of urban climate adaptation governance arrangements. Furthermore, it offers a first evaluation of the performance of those governance arrangements in terms of effectiveness, legitimacy and fairness. Finally, conclusions related to the types of responsibilities of local public authorities are drawn, showing how indispensable they are for both adaptation planning and action.

P-4409-25

Fostering Socio-Ecological Resilience to Climate Change by Shifting from National to Negotiated Law-Making Approach
B. Mohamed (1); O. Barriere (2)

(1) Head, Research Laboratory on Territorial Governance, Human Security and Sustainability (LAGOS), Public law department, faculty of law, economics and social sciences of agadir, Agadir, Morocco; (2) Researcher in Environmental Law and Anthropology, Institute of Research for Development (IRD), Umr espace–dev, Montpellier, France

International and national laws constitute a legal positivism which, by definition, excludes any form of legal pluralism. At the same scales, we see a growing recognition that territorially based communities since regulatory frameworks are mostly enacted on international or national levels. Face to climate change challenges, it is hence necessary to investigate how local communities can be involved in climate actions if we assume that existing top–down regulatory frameworks will not fully consider socio–ecological adaptations and resilience as highly crucial for local communities to persist and maintain their identities.

The interrelations between governance scales cannot exclude local territories. At the local level, communities tend to adapt and build their resilience to climate change by regulating the relations among groups and individuals and between social and ecological systems. Therefore, the idea of a law emerging from the bottom is becoming increasingly relevant in order to enhance the bottom–up approach as an appropriate coping strategy. In other terms, the law–making processes will no longer remain exclusively vertical but will evolve in a horizontal mode, thus abandoning the power relations to embrace the logic of negotiation.

Two examples of negotiated law–making will be presented in this research: the first pertains to the ongoing construction of a socio–ecological resilience pact in the Moroccan High Atlas involving two tribes (including four rural communities and regions) and their members. Results show that the behavioural engagement. The second case concerns the formalization of an already–implemented pastoral pact being adopted in the French Cevennes and involving sixteen counties (including one department and one region). In each case, the co–construction process is put forward and analyzed on the basis of a territorial project. The three–dimensionality aspect of the project (involvement of agro–pastoral actors, decision makers and experts) is presented as the core pillar for the design and implementation of concerned regulatory frameworks. These frameworks, materializing a territorial law perceived and formalized in a solemn text labeled «territory pact», fully integrate national laws by local deliberation.

P-4409-26

Why establish a climate legislation to address climate change in a Latin American context?
P. Moraqa (1); N. Kugler (2)

(1) University of Chile, Faculty of Law, Santiago, Chile; (2) Aix–Marseille Université, Faculté de droit, Aix–Marseille, France

The most ambitious Latin American countries have had a sustained political commitment with regards to the climate change actions as it can be seen in the public policies elaborated since the signature of the UNFCCC – especially in the commitment of 2009 – and the current resourceful position during international negotiations.

In this context, the initiative of a climate legislation seems
to be an adequate way for institutional strengthening and coordination of climate change at national, regional and local level. This is relevant in the current context of the national contributions’ definition with regards to the Conference of the Parties (COP) in Paris in 2015.

The overall objective of this presentation is to demonstrate the necessity and viability of climate change legislation for Latin American countries and outline the recommended basic content of such a law to support the determination of the countries’ Intended Nationally Determined Contributions (INDC) which are to be presented to the UNFCCC secretariat in the lead-up to the 21st COP in Paris in 2015. At a time when strengthening public policy on climate change can be a cause for concern in certain sectors of society, the results of this presentation will ground the debate on climate change legislation in objective terms and will deliver concrete inputs and tools to demonstrate the need and viability of such legislation.

P-4409-27

Ex-post evaluation of the Kyoto Protocol: Four key lessons for the 2015 Paris Agreement

R. Morel (1) ; L. Shishlov (1)
(1) CDC Climat, PARIS, France

Agreed in 1997, following the 1992 United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol (KP) is the first international tool focused on greenhouse gas limitations involving a range of countries: in its final configuration, thirty six developed countries committed to reduce their emissions by 4% between 1990 and 2008–2012 – the first commitment period (CP1). In April 2014, the data from the CP1 was officially published. This report thus presents the first comprehensive ex-post analysis of the first period of the KP.

Based on the results of this report, it is possible to draw four key lessons from the Kyoto experience for the establishment of a new global agreement that is expected to be signed in Paris in 2015:

1. Expanding the coverage: striking a balance between overall environmental integrity and flexibility for specific circumstances
2. Removing the virtual specter of internationally legally binding commitments and limiting the focus on methods of compliance
3. Focusing on MRV processes
4. Providing flexibility in the agreement and its adoption process

P-4409-28

Medium term implications for Africa’s adaptation planning in Agriculture

V. Orindi (1) ; J. Kinyangi (2) ; S. Kingunya, (3)
(1) National Drought Management Authority, ADa consortium, Nairobi, Kenya; (2) ILRI, Ccafs east africa, Nairobi, Kenya; (3) Ministry of Environment, Water and Natural Resources, Climate change secretariat, Nairobi, Kenya

Many of the sustainable development goals to 2030 recognize the role agriculture can play in ending hunger, assuring food and nutrition security as well as promoting healthy lives with a sustained income and economic growth; thereby reducing poverty globally. For Africa, a post 2015 agreement presents the opportunity to merge a shared vision on sustainable development with that which stipulates a pathway to a low carbon transition of food systems. However, it is unlikely, given the short time available to prepare an agreement in Paris in 2015, that the Intended Nations Framework Convention on Climate Change (UNFCCC) subsidiary bodies and work streams will conclude discussions on agriculture to pave way for a new climate deal.

The national adaptation plan (NAP) process was established in 2010, under the Cancun Adaptation framework of the UNFCCC. It was intended as a mechanism for countries to address their vulnerability to the impacts of climate change, building their capacity to adapt to current and future climatic changes. A key focus is to integrate climate change adaptation into development planning processes and strategies across all sectors and at local to national scales. Under this framework NAPs address medium to longer term needs building on experiences of Least Developed Countries (LDC) National Adaptation Programme of Action (NAPAs). If we examine the state of the negotiations, the subsidiary body on implementation (SBI) is currently considering guidelines for the formulation of NAPs. The LDC Expert Group (LEG) has identified the need to fast track the application of NAP guidelines emphasizing integrated development planning as a key consideration. Through the adaptation planning process, we examine how Africa is dealing with agriculture.

Since NAPA experiences are being incorporated into a new set of guidelines for NAPs, it is expected that any emerging protocol will highlight specific agriculture, fisheries and forestry actions. The result is that agriculture and food security, which is to a great extent reflected in proposed and ongoing country NAP programme, receives greater attention in defining the medium and long-term issues around food security and food consumption. Because these issues are not yet well understood, and are often bundled with concerns about trade and commerce and non-food products from alternative land uses such as biofuels, it is important to foster dialogue for the parties as they prepare for the upcoming COP21 in order to reach agreement on how to treat agriculture in a new global deal on climate.

Under the NAP process, many countries have conducted some or other form of impact assessment, usually on a sectoral basis. There exist no guidelines for initiating and completing risk and vulnerability assessments of the agriculture sector and particularly as it relates to the impacts of climate change on agriculture as well as the impacts of agriculture as a contributor to climate change. In many cases too, the economic impacts of climate related risks have not been enumerated therefore compelling the design of effective adaptation strategies and measures at the national level. The inclusion of ‘national planners’ is therefore critical to this process, such as the ministries of finance for support for the Global Support Programme (GSP) under the Global Support Programme (GSP) is crucial to advancing the NAP process. In addition, the identification and procurement of funding for adaptation is only nascent and limited to early action, therefore it is not expected that agricultural adaptation will receive significant funding commitments in the foreseeable medium term period post 2015 and pre-2020.

P-4409-29

The Road to Paris and beyond: Prospects for International Climate Policy

H. Ott (1) ; L. Hermwille (2); W. Obergassell, (2)
(1) Wuppertal Institute for Climate, Environment and Energy, The President’s Office, Berlin, Germany; (2) Wuppertal Institute for Climate, Environment and Energy, Transport and Climate Policy, Wuppertal, Germany

All commentators agree that the climate conference in Lima (COP20) left a great deal of work for diplomats on the road to Paris later this year. The talks produced a quarry of language the negotiators can choose from. What was a mere annex to the “Lima Call for Climate Action” was further expanded in a first round of intersessional meetings in Geneva in February and formally as a negotiating text. Narrowing down the options will be the major task for the upcoming sessions. While the progress on the post-2020 agreement (Workstream 1) was perceived as slow and tedious, some elements of the developments in Workstream 2 (pre-2020) were rather positive and it has developed into a forum of open exchange, thus establishing a new and fruitful mode of collaboration within the UNFCCC process.

Our analysis is guided by a structurational regime model (Arts, 2000). This model assumes that the UNFCCC international system is a bundle of features that structure that guides the agency of firms and individuals within those socio-technical systems that are responsible for driving global climate change. The UNFCCC structures behavior via the implementation of formal treaties in the respective national law of the Parties to the treaty, but also directly by providing signification and legitimation to transnational and subnational institutions to govern climate change, and immediately to corporations and consumers to develop...
more sustainable behavioural routines.

Based on this model, we analyse the „Lima Call for Climate Action“, the negotiating text formally adopted in Geneva in February 2015, and other developments in Lima and thereafter. We look into the elements that have been tabulated for the new global treaty to be agreed in Paris in 2015 and discuss their potential contributions. From this we derive recommendations for a fair and effective treaty.

Our analysis shows that the UNFCCC hitherto failed to provide an adequate impulse to act on climate change. It has become increasingly obvious that the UNFCCC institutional system as it is designed now is not delivering what it is supposed to do according to Article 2 UNFCCC: to prevent a dangerous anthropogenic interference with the climate system. This is due in large part to the consensus-based approach, which does not work well with a quantity-based system of commitments but rather calls for other forms of cooperation. The concept of Multi-Dimensional Commitments developed by the Wuppertal Institute might offer a way out of this dilemma. Furthermore, the article explores a fresh start, options to supplement the UNFCCC system with an alliance of countries that want substantial progress on climate protection – an alliance of the ambitious or a forerunner club. Such a special treaty outside of the UN framework, if appropriate feedback mechanisms are established within UNFCCC, could help injecting the much-needed dynamic that is required to bring our civilization on a path compatible with earth’s ecological limits.

P-4409-30

Climate Governance in two non-independent Caribbean Insular Territories: two different or similar trajectories?

J. Priam (1)
(1) Servicios Científicos y Técnicos, Doctoral student, San Juan, Puerto Rico

This contribution shows how two non-independent islands of the Caribbean reflect the multiple scales dynamics for climate governance. For Puerto-Rico, the adopted solutions must be understood through USA relation and for Guadeloupe, through Europe and France.

To do so, this work synthetizes the first initiatives regarding wind energy on both islands; and the recent ones/ or projects since 2009. We explore then the emerging representation of climate change issues inside two insular territories or even to their metropoles. We present here some international key documents or political discourses in Puerto-Rico and Guadeloupe that contribute in understanding climate governance within islands.

P-4409-31

Multilevel climate governance, between deliberative system, precaution and shared responsibilities

B. Reber (1)
(1) CNRS–Sciences Po Paris, Centre de recherche politique de Sciences po (Cevipof), PARIS, FRANCE


If climate sciences requires interdisciplinary approaches (Jeandel and Mosseri, 2011), it is the same for climate multilevel governance (Winter, 2011; Brondizio, et alii, 2014). We have chosen here three promising ones: deliberation, pre-emption and capacity building. Initial evidence suggests that deliberation and capacity building are central. Initial evidence suggests that deliberative system is promising in the democratization and adaptation of the two kinds of justice entailed (corrective and distributive) that is not already done in UNFCCC. The common climate requires a common approach according a balanced cooperation between the three levels of governance, that can be constructed through the combination of inclusive and deep deliberation among actors (humans, publics and institutions), balanced between scientific and normative assessments, in a «conversation» among distributed responsibilities.


P-4409-32

Unlocking deadlocked negotiations: The relevance of group pressure and policy learning in the global climate negotiations

K. Rietig (1)
(1) Department of Politics and Public Policy, University of Kent at Canterbury, Canterbury, United Kingdom

The UNFCCC negotiations have been deadlocked for over 20 years due to incompatible national interests. At the same time, the objective of avoiding dangerous climate change drifts out of reach with growing urgency. Does this indicate that reaching an agreement is now impossible? We argue that the issue of UNFCCC negotiations is to be understood as the result of a dynamic process which is far from stationary. If this process needs to be understood as a process of learning among states, we need to consider how external factors and domestic factors influence the ability of states to learn and how this learning process can be stimulated. This question is central for policy learning. We argue that learning is a key-multiplying factor in accelerating the process of policy diffusion via the international level. Learning can be a helpful factor to progress along transformative pathways.
to sustainable development, in particular effective climate mitigation and adaptation. Within the UNFCCC negotiations, countries can learn from each other’s successes in low carbon economic development, share knowledge on designing domestic climate legislation that is both achievable and efficient, and come to understand that addressing climate change is an opportunity to create a green industrial revolution, thus entering on transformative pathways towards sustainable development. Recognizing that the barriers to action on climate change can even influence how actors understand the issue and result in readjustments to negotiation positions based on altered national interests. In this paper, therefore, these expert knowledge and belief-based types of learning are currently altering the negotiation dynamics within the UNFCCC. Transgovernmental city networks and non-governmental organizations are creating non-negotiation settings for governmental representatives to explore options and learn from other countries’ successes. These learning platforms and networks were established by a number of actors to help countries share their experiences with low carbon economic development plans to address climate change while decoupling their economic growth from negative impacts. Based on interviews and participant observation at the UNFCCC negotiations between 2013 and 2015, this contribution examines the learning among government representatives about each other’s low carbon economic development plans and climate legislation within (UNFCCC) non-negotiation forums and increasingly formal negotiations. Mutual learning and policy entrepreneurial strategies of key negotiators helps to create positive competition towards more ambitious climate legislation on the national level. Presentational climate policies in the UNFCCC creates group pressure among countries to support their national interests over time towards increasing cooperation on sustainable development.

P-4409-33

Climate change governance in Small Island developing States

M. Scobie (1)
(1) The University of the West Indies, Institute of International Relations, St. Augustine, Trinidad and Tobago

Climate change governance in Small Island developing States (SIDS) is a pressing priority to preserve livelihoods, biodiversity and ecosystems for the next generations. Understanding the dynamics of climate change policy integration is becoming more crucial as we try to measure the success of environmental governance efforts and chart new goals for sustainable development. At the international level, climate change policy has evolved from single issue to integrated approaches towards achieving sustainable development. New actors, new mechanisms and institutions of governance with greater fragmentation in governance across sectors and levels make integration of policy in the area of climate change governance even more complex. What are the frameworks to achieve successful climate change policy integration in environmental governance – especially as the complex interconnectivity of new actors, institutions and procedures of international negotiations is evolving? Is the policy coherence framework useful or indeed applicable for environmental governance in developing states more generally and for SIDS in particular? This article reviewed the debates around policy coherence for climate change governance, introduces a framework to test or measure policy coherence and evaluates the extent to which this has been the case for current actual regional climate change governance processes in Caribbean States. The findings fill a gap in the literature on climate change governance through policy coherence in SIDS.

P-4409-34

Review of the experience with monitoring uncertainty requirements in the Clean Development Mechanism

I. Shishlov (1); V. Bellassen (2)
(1) CDC Climat, Research, Paris, France; (2) INRA, Research, Dijon, France

In order to ensure the environmental integrity of carbon offset projects, emission reductions certified under the Clean Development Mechanism (CDM) have to be ‘real, measurable and additional’, which is ensured inter alia through the monitoring, reporting and verification (MRV) process. MRV, however, comes at a cost that ranges from several cents to EUR1.20 and above per ton of CO2e depending on the project type. This article analyzes monitoring uncertainty requirements for carbon offset projects with a particular focus on the trade-off between monitoring stringency and cost. To this end, existing literature is reviewed, overarching monitoring guidelines, as well as the 10 most-used methodologies are scrutinized, and finally three case studies are analysed. It is shown that there is indeed a trade-off between the stringency and the cost of monitoring, which if not addressed properly may become a major barrier for the implementation of offset projects in some sectors. It has then demonstrated that this trade-off has not been systematically addressed in the overarching CDM guidelines and that there are only limited incentives to reduce monitoring uncertainty. Some methodologies and calculation tools as well as some other offset standards, however, do incorporate provisions for a trade-off between monitoring costs and stringency. These provisions may take the form of discounting emissions reductions based on the level of monitoring uncertainty or more implicitly through allowing a project developer to choose between monitoring a given parameter and using a conservative default value.

P-4409-35

Designing monitoring rules in climate policy: the uncertainty issue

I. Shishlov (1); V. Bellassen (2); F. Lecocq (3)
(1) CDC Climat, Research, Paris, France; (2) INRA, Research, Dijon, France; (3) Centre International de Recherche sur l’Environnement et le Développement, Nogent sur Marne, France

This paper assesses the economic and environmental efficiency of three different approaches to treat monitoring uncertainty in climate policy and evaluate monitoring rules, minimum certainty thresholds and discounting proportional to uncertainty. Our microeconomic model of the behavior of profit-maximizing agents demonstrates that under the simplest set of assumptions – likely representative of many practical cases – the regulator has no interest in reducing unbiased monitoring uncertainty. However, in the presence of information asymmetry monitoring uncertainty hampers the integrity of climate policy. We find that in that case applying discounting proportional to monitoring uncertainty is preferable to setting minimum certainty thresholds or not enforcing any constraints at all, as it is currently practiced in most carbon pricing mechanisms.

P-4409-36

Forecasting the Paris Agreement

D. Sprinz (1) ; G. Bang, (2) ; J. Hovi, (3) ; S. Kalbekken, (2) ; A. Underdal, (3)
(1) PIK – Potsdam Institute for Climate Impact Research, Transdisciplinary Concepts & Methods, Potsdam, Germany; (2) CICERO, Oslo, Norway; (3) University of Oslo, Political science, Oslo, Norway

International negotiations are underway to conclude a 2020+ agreement in Paris in December 2015 within the confines of the UN Framework Convention on Climate Change (UNFCCC). Moreover, it is clear that such an agreement presently clear nor whether any agreement will be concluded by the end of this year. To fill this void, we undertake a prediction of the Paris Agreement by the Predictioneer’s Game (Bueno de Mesquita 2009a).

The Predictioneer’s Game builds on three decades of model development and is an advanced expert system on hypothetical negotiation model with incomplete information between N parties who make bilateral negotiation offers and counteroffers. Based on knowledge of who the actors (or stakeholders) are, their basic influence in world politics, the salience of the specific issue under negotiation (see
below), the actors position on the issue, as well as their flexibiliy on that position, the Predictioneer's Game forecasts the negotiated outcome round-by-round until no additional utility can be gained on average. The model has been used to predict outcomes on a wide range of games and policy issues. In Predictioneer, Bueno de Mesquita correctly predicted the outcome of the 2009 Copenhagen Conference of the Parties – despite high expectations for a cooperative outcome at the time (Bueno de Mesquita 2009b).

For the conference “Our Common Future Under Climate Change,” we will undertake a prediction of the likely common mitigation goal of the parties negotiating under the auspices of the UNFCCC. We will concentrate on the most important country actors and pertinent negotiations groups. In addition, we will undertake a prediction of the likely outcome of a Green Climate Fund (GCF) negotiations on “loss and damage” and its potential inclusion in a Paris agreement.

In order to calibrate our input data, we will draw, on the one hand, on the expertise provided by CICEP Norwegian Center for Excellence in Research – Strategic Challenges in International Climate and Energy Policy, which comprises CICERO, the University of Oslo, and the Fridtjof Nansen Institute, and PIK – Potsdam Institute for Climate Impact Research, on the other hand.

The analysis will be undertaken in April–June 2015 in lieu of the Intended Nationally Determined Contributions (INDCs), corroborated by a broad range of robustness checks to both reflect uncertainty about input values and external shocks on the negotiation dynamics.

Initial test calibrations of the model suggest that the common mitigation goal will not substantially differ from three clashes of history. A target in late 2014, an agreement will be reached after late 2015, and an extension of the “loss and damage” negotiations towards a compensation fund will not materialize in the near future.

References
Bueno de Mesquita, Bruce. 2009b. «Recipe for Failure – Why Copenhagen Will Be a Bust: And Other Prophecies from the Foreign-Policy World’s Leading Predictioneer.» Foreign Policy.

**P-4409-37**

Transparency and Accountability in Climate Finance Governance

**AS. Tabau (1)**

(1) Université de La Réunion, Faculté de droit et d’économie, Saint Denis, La Réunion, France

Climate finance, to reduce greenhouse gas emissions or to adapt to the harmful effects of climate change, remains one of the central issues of current international negotiations. Progress in the fulfilment of the developed countries collective commitment, adopted in 2009 in Copenhagen and set out, the following year, in the Cancun Agreements, to provide new and additional resources to developing countries, in the range of 100 billions of dollars by 2020, may determine the conclusion of an inclusive and ambitious agreement in 2015.

However, some developed countries advanced the argument of the economic crisis to postpone the provision of public finance, to ask for the efficiency of funds provided in terms of climate change mitigation, and to consider that a major part of the climate finance will come from the private sector. Many developing countries, more preoccupied by the effectiveness of climate finance, continued their efforts. By 2014, a 2015 agreement to the actual disbursement of funding and consideration of adaptation to climate change, as well as capacity building, to estimate their needs. Finally, voices had been raised about the possible environmental impacts, as well as the depletion from previous climate projects, putting emphasis on the need for the integrity of climate finance.

These demands for efficiency, effectiveness and integrity of climate finance plea for transparency and accountability at all stage of the funding cycle, that is to say from its mobilisation to its disbursement and administration. Indeed, transparency and accountability are core democratic values, linked to the procedural rights to information, participation in decision-making and access to justice that should apply to the overall governance of climate finance. These elements, participating to public scrutiny in the field of climate finance, are particularly important to enhance developing countries’ confidence by ensuring their commitment and to evaluate, progressively, developing countries’ needs in order to take up the challenge of dealing with climate change. They also appear crucial to address the holistic approach of climate action, avoiding deleterious side effects of internationally funded projects, and more broadly favouring public acceptance of the efforts needed.

Yet, the assessment of the provided and received financial support, its new and additional character or its effects on the ground raises numerous difficulties. Despite the establishment of a Green Climate Fund (GCF), it is still centralize as much as possible the financial mechanism of the international climate regime, and the setting up of a Standing Committee on Finance (SCF), intended to encourage the coordination of climate finance, governance in this domain remains highly fragmented. Different scales of decision and action are mobilized (international, regional, national and local), within the climate regime (UNFCCC) as outside. Climate funds are functioning, moreover, according to different rules and are not all managed by the same institutions. This is even truer if one takes into account private climate finance next to public climate finance.

Therefore setting up a transparency and accountability system in climate finance constitutes a major challenge, as related rules and procedures are currently incomplete and inconsistent. That is why, to elaborate such a system, the SCF and the GCF are proceeding from relatively unprecedented work, in particular, by encouraging involvement of all stakeholders. Initiatives from multilateral banks of development, the Organisation for Economic Co-operation and Development and some non-governmental organisations, like Transparency International, are also relevant in this regard. From then on, it is especially interesting to study in details this process of normative production that could apply to other fields of climate governance.

Indeed, it first favours a better understanding of the mapping of the current transparency and accountability systems relevant for climate finance, which is necessary to compare them, in order to identify their harmonisation and/or articulation potential. This presentation aims to analyse these four stages to improve the overall climate finance governance.

**P-4409-38**

The Continental Approach to Climate Change: An Analysis of the European Union’s Emissions Trading System

**J. Wellman (1)**

(1) London School of Economics and Political Science, Geography and Environment, London, United Kingdom

The European Union’s Emissions Trading System stands as a model for managing a changing climate in a complicated international environment. As the international community progresses for negotiations, it is important to understand players and their performance in the EU’s governance system is essential to validating the potential success of emissions markets. Concerns that wealthy countries will purchase permits, rather than reduce their real emissions, have created skepticism about emission trading’s potential for success.

In this study, I examine ambition exhibited by countries in using less than maximum levels of offsets to achieve Phase II reductions. Through fuzzy–set Qualitative Comparative Analysis, I explore a number of variables including: economic growth, Green Party representation, public opinion, and renewable energy investment to construct a model explaining variety in exhibited ambition among ETS countries. Results show that renewable energy and public opinion matter, but are also complemented and conditional to other factors. These results, related to the potential success of the ETS and setting the standard for other emission trading systems, are particularly useful to countries and players, who still need to assess the potential of their success.
With the exception of climate skeptics who relegate climate change only as a natural phenomenon to the exclusion of all human causes, climate change is not referred to nature. Climate change as a whole refers to an abstract scientific phenomena and/or a disruption of the natural order by human activities. Characterized by science, climate change involves a complex interpretative framework linked to a network of measurements, statistics and modeling, combined with scientific judgments about their relevance. It is therefore important to understand how these changes are part of the natural and built environments both in terms of representations and of social practices. We seek to address the interests of narratives regarding these issues, in particular, adaptation to climate change in urban space. Our collection of city-dwellers stories in urban situations of various constraints and resource levels as well as the CSO narratives framing their action tells us about adaptation to climate change. The capabilities require to take into account both the constraints and the resources with which people have to live and operate daily to adapt to changes of various kinds. The important thing is that it is possible to develop a reflection on the capabilities from ordinary stories. This means to explore sustainable practices in everyday life. These practices will allow us to envision social invention of new forms of action to support or resist normative injunctions in the field of adaptation to climate change. The problematic issue is to see if the exploration of capabilities through stories can be a path to a sustainable culture.

K-4410-03
Urban narratives and collective mobilization in the field of adaptation to climate change

N. Blanc (1)
(1) CNRS, LADYSS 7533, Paris, France

Reinvigorating International Climate Policy: A Comprehensive Framework for Effective Non-state Action

S. Chan (1); H. Van Asselt (2); H. Thomas (3); K. Abbott (4); M. Beisheim (5); M. Hoffmann (6); B. Guy (7); N. Höhne (8); A. Hsu (9); P. Pattberg (10); P. Pauw (11); C. Ramstein (12); O. Widerberg (10)

(1) German Development Institute, Bonn, Germany; (2) Stockholm Environment Institute, Oxford, United Kingdom; (3) Blavatnik School of Government, Oxford, United Kingdom; (4) Arizona State University, Tempe, AZ, United States of America; (5) German Institute for International and Security Affairs, Berlin, Germany; (6) University of Toronto, Toronto, Canada; (7) Natural Resources Defense Council, New York, United States of America; (8) NewClimate Institute, Köln, Germany; (9) Yale Center for Environmental Law & Policy, New Haven, United States of America; (10) VU University Amsterdam, Amsterdam, Netherlands; (11) German Development Institute, Bonn, Germany; (12) Institut du développement durable et des relations internationales, Paris, France

As countries strive to negotiate a new climate agreement in time for the Paris climate summit in December 2015, a different kind of climate politics is emerging as cities, regions, businesses, and civil society groups take mitigation and adaptation actions, independently and together with each other and with national governments and international institutions. In Paris, governments have an historic opportunity to develop a framework to catalyze, support, and steer these initiatives. Social science research highlights the need for a comprehensive approach that promotes ambition, experimentation and accountability, and avoids unnecessary overlaps. This contribution specifies the functions of and design principles for a comprehensive framework for non-state climate actions that could build positive linkages and provide effective coordination.

Drawing empirical lessons learned from sustainable development governance (in particular ‘Partnerships for Sustainable Development’ and ‘Actors in Action’), we propose a comprehensive framework as a long-term program to support, strengthen, and orchestrate non-state initiatives that contribute to international climate goals, targets and agreements.

K-4410-02
The political economy of decarbonisation

A. Pegels (1); L. Wilfried (1); T. Altenburg (1); Y. Georgeta (1)
(1) German Development Institute / Deutsches Institut für Entwicklungspolitik (DIE), Sustainable economic and social development, Bonn, Germany

What and how we produce and consume is largely shaped by markets. However, markets fail to solve many of the environmental challenges we are facing. Therefore, we need governments to intervene, thus reclaiming the primacy of public policy in setting and implementing societal objectives. While safeguarding the sustainability of human life on our planet makes this kind of government intervention a highly normative undertaking, its economic case is strong as well – the success stories of such ‘green’ frontrunners as Germany and Denmark demonstrate the competitiveness potential of the new technologies. However, as shown by decades of discussion on industrial policy, government intervention almost invariably brings about risks of political capture and government failure. Government intervention towards sustainability is thus not only governed by ethical norms, but also by politics. The risks of failure are magnified by the urgency and scale of today’s global environmental challenges, requiring particularly bold, comprehensive and well-orchestrated government intervention under high uncertainty. By highlighting lessons learned from practical cases of both success and failure, we show how these risks can be, and have been, managed. In particular, we submit that a broad-based social vision and contract need to be forged – supported by change coalitions and coupled with policy process safeguards, openness to policy learning, and an alignment of transformative policies with market mechanisms.

K-4410-01
New norms and institutionnal practices towards radical political changes

Y.C. Zarka (1)
(1) Université Paris Descartes, SHS, Paris, France

The theme of my lecture will be the relationship between cosmopolitical citizenship and political citizenship faced with climate change. The questions considered will touch as much on general principles as on an examination of concrete examples of collective action in local and national contexts. In the age of the Anthropocene, the urgent and indispensable norms and modes of regulation to save our species have not yet been clearly formulated. The deep reasons for the gaps between diagnoses and action have their roots in various levels of the way in which societies function.

It is by mobilising the collective action of citizens in each state, as well as that of human beings as citizens of the world, that we shall probably find a large part of the answers. Our discussions will thus be situated on two levels: cosmopolitical and political. We are in fact living in a time when political citizenship can no longer ignore the status of every individual as a citizen of the world; that is to say, our responsibility with regard to the present and the future of the earth and of the whole living world.
maintenance of the framework must be collaborative, and the framework itself must be jointly "owned" by the UNFCCC secretariat and participating non–state actors and initiatives. Second, a comprehensive framework should include a global clearinghouse, bringing together existing sources of information. The clearinghouse should also be used upon existing registries maintained by a network of non–state actors in partnership with the UNFCCC. Finally, as climate actions are heterogeneous, the platform should combine low thresholds for inclusion with a layered structure that would provide increased visibility – coupled with increased levels of accountability – for particularly significant actions.

The road to Paris offers a unique opportunity to ratchet up ambition, mobilize action and engage more actors in climate action. Governments and non–state actors can cooperate on a robust, capable, and long–term comprehensive framework that orchestrates and supports non–state initiatives to contribute to internationally agreed climate outcomes, and that counters the inefficiencies of a fragmented governance landscape. Yet impulsion this approach we need to avoid repeating the mistakes of previous frameworks.

O-4410-02
Community Renewable Energy in Australia – examining and comparing an emerging social movement

F. Mey (1)
(1) Institute of Environmental Studies – University of New South Wales, Sydney, School of Biological, Earth and Environmental Sciences, Sydney, NSW, Australia

Local action for global problems finds expression in the growing field of Community Renewable Energy (CRE). Community actors develop and own renewable energy projects and play an increasingly important role in the transformation of energy system providing local solutions (del Río & Burguillo, 2009; Hicks & Ison, 2011; Rogers, Simmons, Convery, & Weatherall, 2012; trend:research GmbH & Leuphana Universität Lüneburg, 2013; Walker & Devine-Wright, 2008; Walker, Hunter, Devine-Wright, & Evans, 2007).

Australia is a relative newcomer to this development, yet many communities are becoming increasingly enthusiastic about the Community Renewable Energy. However the country’s communities seem to face particular challenges when it comes to implementation due to a limited support by the national government and a rather complex energy market (Hicks & Ison, 2011).

The CRE movement in Australia counts currently (as of October 2014) around 60 groups attempting to develop projects and 10 operating projects across the country (ISF, 2014).

The presentation will present results of two national surveys of community energy projects in Australia and provides insights into the "scope, scale and character" of this nascent community energy movement. The surveys were created and conducted in 2012 and 2014 by members of the Coalition for Community Energy, which included the two authors of this article.

The results of the survey have been analysed in a similar vein to that offered of the UK by Seyfang et. al. (2013). Like them, we use the STEEP (social, technical, environmental, economic, political) and SWOT (strengths, weaknesses, opportunities, threats) frameworks as the foundation of our analysis. We discuss the key issues for the further development of community energy in Australia in its socioeconomic and political context.

However, we take our analysis a step further to reflect on how this emergence in Australia has been different from other countries and what this means for different understandings of the nature and role of community energy.

For this component we employ existing concepts of community energy (Walker & Cass, 2011; Walker & Devine-Wright, 2008; Walker et al., 2007) and social movement theory (DFID, 2005; Long & Smih, 2008; Seyfang & Smith, 2007). We draw on a literature review and historical data from other countries such as Denmark, Germany and the UK.

O-4410-03
Collective national and transnational action towards «green grabbing»

S. Vigil (1)
(1) FNRS Research Fellow, CEDEM University of Liége, Liége, Belgium

Land remains the most fundamental productive asset for the vast majority of populations in the Global South. Agriculturists’ pre-existing vulnerabilities are not only compounded by climate change and the global economic crises, but also by large–scale land acquisitions that have risen since the convergence of multiple global crises (financial, environmental, energy & food) (Borras & Franco, 2012). If we add to that the fact that climate change has raised awareness of the country’s communities seem to face particular challenges when it comes to implementation due to a limited support by the national government and a rather complex energy market (Hicks & Ison, 2011).

Australia is a relative newcomer to this development, yet many communities are becoming increasingly enthusiastic about the Community Renewable Energy. However the country’s communities seem to face particular challenges when it comes to implementation due to a limited support by the national government and a rather complex energy market (Hicks & Ison, 2011).

The CRE movement in Australia counts currently (as of October 2014) around 60 groups attempting to develop projects and 10 operating projects across the country (ISF, 2014).

The presentation will present results of two national surveys of community energy projects in Australia and provides insights into the "scope, scale and character" of this nascent community energy movement. The surveys were created and conducted in 2012 and 2014 by members of the Coalition for Community Energy, which included the two authors of this article.

The results of the survey have been analysed in a similar vein to that offered of the UK by Seyfang et. al. (2013). Like them, we use the STEEP (social, technical, environmental, economic, political) and SWOT (strengths, weaknesses, opportunities, threats) frameworks as the foundation of our analysis. We discuss the key issues for the further development of community energy in Australia in its socioeconomic and political context.

However, we take our analysis a step further to reflect on how this emergence in Australia has been different from other countries and what this means for different understandings of the nature and role of community energy.

For this component we employ existing concepts of community energy (Walker & Cass, 2011; Walker & Devine-Wright, 2008; Walker et al., 2007) and social movement theory (DFID, 2005; Long & Smih, 2008; Seyfang & Smith, 2007). We draw on a literature review and historical data from other countries such as Denmark, Germany and the UK.
outcomes as well as to underline the obstacles that persist in the implementation of socio-environmentally sustainable agricultural development projects.

ABSTRACT BOOK

P-4410-01

Strengthening the climate action movement: strategies from histories

L. Delina (1) ; M. Diesendorf (2)
(1) Independent Scholar, South Cotabato, Philippines; (2) Institute of Environmental Studies, Sydney, Australia

Since many governments lack the motivation to lead deep emission reduction initiatives, the climate action movement must strengthen its campaigns. This paper offers strategies for the movement derived from historical analysis of mechanisms that achieved effective social change in the past. Common elements of climate action with past social change movements, together with some differences, are identified. Although technologies, strategies and tactics vary, climate action groups can agree to support a shared common goal: effective climate mitigation, that can be accomplished not only through outward-oriented tactics, but also by forms of climate activism that are prefigurative – that is, based on action within local communities. Furthermore, the diverse campaigns take different actions at different scales and spaces, conducted by heterogeneous groups, should be integrated by establishing national and international hubs to facilitate coordination and communication.

P-4410-02

“Re-Imagining Radical Climate Justice for the Post-Paris World”

F. John (1)
(1) University of California, Santa Barbara, Sociology, Santa Barbara, United States of America

The science is not in question: climate change is here now, not in the future,[1] and it is already having devastating effects on people’s lives. That’s the bad news, of course.

Even worse, the massive social, economic, and political inequalities already generated by neoliberal capitalism would seem to set the social and natural worlds on a collision course which the elites cannot win — even on their own terms — without destroying the basis for all human life. To put it bluntly, the climate crisis is perilous, our 500 year-old economic system cannot see us through it safely, the window for resolving this dilemma is closing inexorably, and the forces arrayed against our common survival are strong, very strong.

The good news is that there’s a global climate justice movement which is growing in numbers, reach, strength, and inventiveness. This movement is impossible to encompass easily, because it consists of literally thousands of organizations at every level — community, city, bio/region, nation, and the global — interlinked in a vast network of networks.[2]

The next few years will be the years that those of us in the climate justice movement must scale up our efforts toward the end of mounting irresistible pressure of all kinds on our governments and on the corporations, banks, and all the institutions of neoliberal capitalism that they serve. We must force them to take the decisive steps we all need and want, such as a fair and binding global climate treaty.

Consider the following:

Parts of the radical left are turning their attention to climate change (System Change Not Climate Change in North America), while many members of the radical climate justice movement are turning their attention to anti-capitalist politics.

At the same time, the Big Green environmental organizations (the Sierra Club in the US), the mainstream global climate justice movement (CAN), and the biggest climate social movement organization (350.org) are all radicalizing.

The same can be said of climate science in general (The IPCC Fifth Assessment Report etc.) and particular climate scientists, such as Kevin Anderson, Alice Bows-Larkin, Michael Mann, James Hansen, et al.

Finally, there is an enormous push coming up from young people, and indigenous forces on all of these levels.

The question is: what are the prospects for synergy and movement building among all these forces? What is the way forward?

It appears evident that we will need to assemble the greatest social movement the world has ever seen to achieve these ends. The global climate justice movement is growing steadily, but it is still far too weak to win — at least for the moment.

This essay will trace some of what it has accomplished so far, asking where the major points of impact lie at the moment, and what strategic decisions must be faced moving forward.


contact between wildlife and humans by impacting the mobility and range of the reservoir species and by influencing their movements. For other side, climate evolution may also exacerbate food insecurity, which can in turn modify human behaviour, particularly by prompting people to look for alternative food sources, such as bushmeat.

3. Low-income countries must reinforce their health systems to detect earlier infectious zoonotic diseases and control outbreaks, by taking into consideration impacts of change in their sanitary strategy and policy. Indeed, health systems are structurally inadequate in the least advanced countries, where they endure rather than anticipate climatic and epidemic conditions and their variations. The recent Ebola epidemic in West Africa bears witness in particular to the need to step up the early detection and management of the emergence of zoonosis taking into account accurate environmental, social and climatic data.

Research and health management regarding these 3 items should be carried out through the "One Health" concept. This holistic approach includes both animal health and human health in their shared environment. The implementation of a multidisciplinary and intersectoral approach requires above all an awareness of its benefits and greater involvement of all the scientific and policy makers. The issue of climate change and its impacts on viral diseases may be an axis of reflection on this integrated approach, and Ebola disease is a topical issue.

Our poster presents some examples of North–South collaboration between teams which are fighting together against both climate change and Ebola crisis.

**P-4410-04**

**Localised Climate Smart Agricultural Practices from the Global Permaculture Movement: Examples from the Semi-Arid Little Karoo in the Western Cape Province of South Africa**

E. Kruger (1)
(1) University of the Witwatersrand, Department of Social Anthropology, Johannesburg, Gauteng, South Africa

A growing global social movement under the banner of permaculture is aimed directly at responding to the effects of climate change and mitigating human impact on our environment, in particular the consequences of unrestrained resource extraction and consumption and non-sustainable agriculture. Permaculture, a conceptual framework that originated in Australia in the 1970s, and now practiced across the globe, provides guidelines for the design of sustainable living environments and the activities that we carry out in those environments. The underlying aim of permaculture design is to create productive anthropogenic landscapes of benefit to both humans and the environments that we inhabit – living and non-living – by reducing the negative impacts of our actions through considered design. In the process, the intention is to also have an actively beneficent impact on those environments.

A principal focus in permaculture is the localisation of resilient food production systems which mimic and integrate with local ecologies and ecosystems, and are designed to achieve maximum potential to occur with climate change as well as reduced access to fossil fuels.

This presentation will introduce central approaches to agriculture and food production in the permaculture framework, and draw upon case studies from anthroponic fieldwork conducted at a permaculture project located in the semi-desert Succulent Karoo biome of the Western Cape province in South Africa. In particular, the discussion will consider the design methods and technologies that have been employed to provide emergency food in a highly degraded landscape of climatic extremes, and in the process contribute towards improved ecological resilience and biodiversity. Examples here include the use of traditional harvesting earthworks such as keyholes, swales and tree pan systems, as well as employing a diverse range of climate specific and resilient productive species grown together to create micro-climates more amenable to food production and human habitation.

Some points that will be considered in this oral presentation are: What is climate smart agriculture? – Some central concerns around climate change and agriculture. What agricultural practice is not smart? What is permaculture? – Case studies of permaculture food production at a semi-arid permaculture in South Africa. How does permaculture address the concerns raised in change climate debates? What lessons can we learn from the permaculture paradigm of climate smart agriculture?

**P-4410-05**

**The Prevalence of HIV/AIDS amongst the Pastoral Communities over Kenya, Uganda, Tanzania and Ethiopia**

G. Otieno (1)
(1) University of Nairobi, meteorology, Nairobi, Kenya

The Human Immune Virus (HIV) and Acquired Immune Deficiency Syndrome (AIDS) have been identified as a major threat to pastoral communities over East Africa. The regional governments have given little attention to this problem due to the perception that Pastoralisms is economically inefficient and environmentally destructive. The study was carried over Kenya, Ethiopia, Tanzania and Uganda to assess the current state of HIV/AIDS prevalence amongst the pastoral communities using desktop review and expert judgment opinion. In Kenya, about 8 million people of Kenyan population depend on pastoralism. In Tanzania the livestock sector contributes about 6.1% to the national Gross Domestic Products (GDP). In Uganda 1.7% of GDP is accounted for by the sector and about 9% of the national GDP in Ethiopia.

In the pastoral districts the average prevalence of HIV/AIDS amongst the community is estimated at 5.7% with this figure expected to increase. The infection rates are being accelerated by factors related to human rights and gender, socio-cultural environment and lack of HIV/AIDS awareness and stigmatization. The HIV/AIDS is not recognized at policy level as a major problem facing Pastoralists yet the statistics show increasing population of HIV/AIDS victims.

The communities refuse to admit the presence and impact of HIV/AIDS within their families with high stigma attached to those affected and infected. The number of livestock has been diminishing through sales to pay the medical expenses when the pastoralists are affected. The study recommends for budgetary support and HIV/AIDS campaign amongst the pastoral districts to reduce the stigma and curb the decreasing number of livestock.

**P-4410-06**

**Now You See It**

L. Perrin (1)
(1) Lola Perrin, London, United Kingdom

I have spent the last year sourcing and interviewing campaigners, inventors and innovators at the frontline of climate justice and placing their words within a music composition for piano and recorded spoken words. The project is a device to drive population awareness of the issues. Interviewees range from grassroots mitigation experts in Africa to Costa Rican media agitators to campaigners in the Arctic. Please note that as of today, the Guardian newspaper is currently picking up on my work, being released end March 2015. I propose for you a Q&A, to be discussed. Following a performance featuring my work – as a musician/layperson/mother of two boys, deeply concerned about our future. I will be situated at a music keyboard/acoustic piano, performing with my artistic, pre-recorded spoken word presentation created from my interviews with major international voices in the climate justice movement, delivered through PA system.

Here follows my press release. I hope to hear back from you: music is an important social device to communicate between expert witnesses and ordinary people and I would like to collaborate with you to create the perfect performance for your vital initiative. I live in London.

**TITTE: ‘NOW YOU SEE IT’**

**FOR PIANO AND AN ORCHESTRA OF WORDS RECORDED FROM ACTIVISTS & INNOVATORS AT THE FRONTLINE OF CLIMATE JUSTICE**

2 min PROMO https://www.youtube.com/watch?v=E5HnQJQ1As4
Fiddling while the roof burns? Tales of coal, justice and grassroots opposition to energy boom in Turkey

E. Turhan (1); AC. Gundogan (2)
(1) Istanbul Policy Center, Sabanci University, Istanbul, Turkey; (2) King’s College London, London, United Kingdom

What links a local group of activists, struggling with few resources to save their communities from the ill of coal-fired power plants to broader social movements to save the planet from burning? And what, in turn, connects global processes of climate change to local livelihoods' demands for spatial and environmental justice? Climate justice, as Pellow and Park (2009) observe, begins with an acknowledgement of climate injustice and views this problem not as an unfortunate byproduct of climate disruption but as one of its core elements, and one that must be confronted if climate crisis is to halted and reversed. Even though the implications need care and community, proposals for the Anthropocene remains limited to property rights and market ideas of justice. However climate justice offers a fresh approach which in practice means energy access for those who do not adequately and sustainable access to the services of energy, workplace justice and occupational health for those who produce energy sources and remediative justice those who are affected by the impacts of hydrocarbon burning. This provides a good entry point to investigate the case of Turkey, which has witnessed exacerbating ecological conflicts since 1990s. Economic growth, rapid urbanization and hydrocarbon-dominated energy policy preferences in the past 2 decades placed immense pressure on the socio-ecological systems in Turkey. These pressures often manifested themselves as ecological conflicts due to land use changes, energy production, mining and associated neoliberal legislative changes. At the peak of these conflicts, Gezi protests of 2013 became the landmark of ecological conflicts in framing climatic-energy nexus as a matter of (in)justice for and by the most vulnerable communities. Yet failure of the Turkish government to take a binding emissions reduction target as the OECD country with the highest rate of emissions increase since 1990 and its ambiguous position in the global climate regime makes it a curious case. Hence in an attempt to demystify the “energy-hungry nation” idea, this paper focuses on the cases of three local movements (Allaia, Karabiga and Yalova) against coal-fired power plants, their changing discourses and the national energy planning under climate change in stitching the gap between developmentalism, energy production and defense of rural–urban commons in Turkey.

ORAL PRESENTATIONS

K-4411-01

Green Economy as a Technocratic Concept: Genealogy and Agenda

J. Foyer (1)
(1) CNRS, ISCC, Paris, France

In 1972 in Stockholm, the environment was considered as a set of constraints, imposing various biophysical limitations on economic activity. At Rio in 1992, the advent of sustainable development introduced changes in this representation: economic development or growth was considered as possibly compatible with environmental protection. In 2012 at Rio, the Green Economy was supposed to represent a further step in the environment-market reconciliation, since through this notion, the environment was no longer considered as a reality to be taken into account and even less as a constraint, but rather as an opportunity. Thus, within 40 years, the discourse has moved from the assertion of a fundamental contradiction and the search for a balance between the environment and the economy, to that of potential synergy. This presentation aims both at tracing a genealogy of the concept of Green Economy and a precise analysis of the moment of its international agenda setting at Rio +20. Our core hypothesis is that the concept of green economy, while conveying a very liberal and economistic worldview, is primarily a technocratic concept that did not stem from the private sector, but that emerged at the interface between academia and international institutions. We also want to analyze the role of the Rio+20 Summit in agenda setting and testing ground for the concept, as a moment of controversy and violent geopolitical confrontation over its definition and vehement criticism on the scope it should be granted.

K-4411-02

CARBON EMISSIONS AND RESOURCE PRODUCTIVITY: Why reviving growth requires a rapid de-carbonization of the global energy system

M. Molitor (1)
(1) SciencesPo, Paris School of International Affairs, Paris, France

Most governments believe that any attempts to reduce their emissions will require giving up on some future economic growth and this has served as the principal barrier to getting global collective action on reducing
The global economy requires exponential growth to function properly and this, in turn, requires an exponential increase in the extraction of natural resources and a decrease in resource productivity. While resource productivity is measured in terms of economic efficiency, it has increasingly been argued that this measure is incomplete and should be supplemented with a consideration of changes in the environmental and social impacts of resource use. This is especially true in the context of resource scarcities and shrinking ecological space. Just as there is a growing understanding that increases in economic efficiency are not sufficient to resolve the crisis of resource depletion, there is also an increasing understanding that the usual metrics of economic progress are insufficient to generate the high employment and levels of material well-being that are required by the new global political economy.

Can such visions and strategies overcome the apparent conflict between the need for greater material well-being and the imperative to avoid the collapse of the planet’s life-support systems? To address this question, we need to consider both the ideas that inform these visions and strategies and the political, economic, and social systems in which they are embedded. The former provide the ethical and intellectual substance of green economy, while the latter continue to shape the trajectory of social, political, and economic development. In short, the quest for a new political economy must be understood as a process of changing social relations that goes beyond the narrow confines of green economy as a market and financial mechanism designed to induce resource conservation and improve resource productivity.

Green economy and its alternatives

K. McAfee (1)
(1) San Francisco State University, San Francisco, United States of America

The growing risks associated with climate change. This is true for all countries, but several studies have shown that the future reductions in growth required to keep global surface temperature increases to less than 2 degrees C will be small relative to the overall increases in growth. While no one has questioned whether it is possible to meet the economic growth requirements of a human population on its way to 9.5 billion people in 2050 by using fossil fuels as the primary basis of delivering both stationary and transport energy.

The global economy requires exponential growth to function properly and this, in turn, requires an exponential increase in the extraction of natural resources and a decrease in resource productivity. While resource productivity is measured in terms of economic efficiency, it has increasingly been argued that this measure is incomplete and should be supplemented with a consideration of changes in the environmental and social impacts of resource use. Just as there is a growing understanding that increases in economic efficiency are not sufficient to resolve the crisis of resource depletion, there is also an increasing understanding that the usual metrics of economic progress are insufficient to generate the high employment and levels of material well-being that are required by the new global political economy.

One major problem is that the global economy is currently growing at an exponential rate. The OECD estimates that global GDP must increase from approximately US$70 trillion today to US$305 trillion by 2050 in order to meet the growing aspirations of an expanding human population. This is an unprecedented level of growth requiring extraordinary improvements in resource productivity. Most of the large-scale resource activities in operation today are deploying capital, energy, and natural resources at levels of resource productivity that will make it nearly impossible to achieve the higher levels of productivity that may be required. The most compelling evidence of this is the waste produced by these activities as waste is the best indicator of resource inefficiency. At 36 billion metric tonnes of carbon dioxide equivalent and growing, the waste produced through the combustion of fossil fuels is the most robust evidence of the least resource productive activity on the planet.

Getting to US$305 trillion is not possible if we continue to rely on fossil fuels as our primary source of delivering useful energy. Fortunately, there are existing and emerging energy technologies, new business models and new models for producing and distributing energy which are capable of delivering the large improvements in resource productivity now required. Furthermore, the level of capital investment required is no more than the amount that we continue to deploy to continue using fossil fuels. The old narrative...

Reducing carbon emissions requires deciding to be a little bit poorer in the future.

is not only out of date but completely inaccurate. The new narrative is...

Reducing carbon emissions is the only pathway to restoring growth at scale and on time.

Green economy and its alternatives

K. McAfee (1)
(1) San Francisco State University, San Francisco, United States of America

Global environmental policy is increasingly framed by discourses of ‘green economy’. Green economy is meant to foster economic growth while decoupling that growth from environmental decline. Its advocates hope that monetary valuation of environmental assets and deficits, economic rationality, and market mechanisms can mute the most ecologically damaging effects of unfettered, globalized capitalism. Some contend that this approach can transform the present crisis into an opportunity. However, others have pointed out that existing discourses on green economy can reinforce longstanding patterns of global inequality.

New peasant and indigenous social movements and their intellectual allies reject the construction of ecological limits as absolute scarcity, focusing less on the finitude of resources and carbon sinks than on the anti-entropic life-giving relationship among human labor, water, soil, sun, and the activities of other species. They question the implicit equations of development with growth, well-being with consumption, and conservation with market rationality. Instead of growth they speak of buen vivir, sumak kawsay, lek’il kuxlejal, ubuntu, radical ecological democracy, etc. These discourses are about living well and living cooperatively both socially and ecologically.

Can such visions and strategies overcome the apparent conflict between the need for greater material well-being and the imperative to avoid the collapse of the planet’s life-support systems? To address this question, we need to consider both the ideas that inform these visions and strategies and the political, economic, and social systems in which they are embedded. The former provide the ethical and intellectual substance of green economy, while the latter continue to shape the trajectory of social, political, and economic development. In short, the quest for a new political economy must be understood as a process of changing social relations that goes beyond the narrow confines of green economy as a market and financial mechanism designed to induce resource conservation and improve resource productivity.

Sustainable energy and development in a dichotomous economy: South Africa

A. Hughes (1), T. Caetano (2), H. Trollip (1), B. Merven (1)
(1) University of Cape Town, Energy research centre, Cape Town, South Africa
(2) University of Johannesburg, Town, South Africa

Currently South Africa is ranked amongst the top 20 emitters in terms of global GHG emissions. Energy consumption, which is heavily coal dependent, is expected to grow significantly in the future as the economy grows, and therefore, unless commitments to decrease GHG emissions are prioritised, GHG emissions will increase dramatically in the medium to long term. Energy modeling in the US, for example, a four fold increase in GHG emissions by 2050 under a scenario of Growth Without Constraints (ERC, 2007).

In terms of Economic development and GDP, SA is considered to be an upper middle income country, with a per capita GDP in purchasing power parity terms of 12 240US$ (World Bank, 2015). However, society in South Africa remains very unequal. The GINI coefficient is 0.69 (StatsSA 2014) and the MDG poverty line of $1.25 (2005ppp) shows that 7.4 percent of South Africans are currently living in extreme poverty, using a poverty line at $2.5 (2005 ppp) per day, this number increases to 29.2% (StatsSA 2013). Lower income households also experience a low degree of energy poverty, defined as inadequate levels of electrification. For example the Department of Energy found that over a third of South African households are energy poor (DOE 2013). Poverty is largely due to high levels of unemployment in the formal sector and low levels of informal sector activity. Using a broad definition of informal sector activity. Using a broad definition of informal sector activity. Using a broad definition of informal sector activity. Using a broad definition of informal sector activity. Using a broad definition of informal sector activity.
unemployment which includes all those currently without work that would like to work, 34.6% of South Africans are currently unemployed (StatsSA 2015).

South Africa is committed to a development path which is both inclusive (reducing inequality, unemployment and poverty), and "green" (reducing greenhouse gas emissions and increasing the sustainability of both the production and consumption of energy). Impacting low carbon development aspirations is the heavy reliance of industry and electricity production on coal. Questions currently being grappled with are: how can we decouple GDP growth and coal use in the economy?, encourage more efficient and equitable use of energy and follow a growth path which promotes job creation in sectors that are less energy intensive, thereby lowering emissions. This needs to be done without negatively impacting aspirations for high GDP growth and increased employment, both of which are economic development priorities which underpin current development policies such as the National Development Plan, and the Growth, Employment and Redistribution Plan.

The question for this paper is therefore: What could a sustainable energy future under a scenario of inclusive growth look like for South Africa?

The paper uses a bottom up energy model of South Africa, SATIM, to explore possible energy pathways and deeper development aspirations, looking specifically at the need for the economy and the likely fuel mix and GHG emissions associated with this until 2050. A CGE model is used to assess how close we are to meeting development objectives, and ultimately whether development and decarbonisation can be complimentary objectives.

References


DOE, 2013. A survey of energy-related behaviour and perceptions in South Africa.


O-4411-02

Can “Green Growth” Guide us into a Sustainable Future?

J. Zalpyte (1); MS. Rhozyel, (2)

(1) Eberswalde University for Sustainable Development, Faculty of Forestry and Environment, Leipzig, Germany; (2) Eberswalde University for Sustainable Development, Faculty of forestry and environment, Berlin, Germany

Prevailing political economy is failing to maintain environmental, social, political and economic coherence. A deep changeover into a new economy is needed “where the acknowledged priority is to sustain human and natural communities” (GTI, 2011: 1). Therefore, it is widely accepted that the current linear so-called “take–make–dispose” economy is not sustainable and that solutions need to be found in order to decrease both the input of limited resources as well as the output of human waste in any form. This paper examines in how far the ideas of „green growth“ are capable to cope with this problem since they promise material welfare while reducing the impacts on the environment. Even though the underlying approaches like a „circular economy“, „zero-emissions economy“ or „Factor x“ seem to be desirable, there is reasonable scepticism in how far advances in resource efficiency can ensure a sustainable future while industrialised societies got used to constantly raising living standards. We show that there is an intrinsic contradiction within the desire for “green growth” guiding the way towards a sustainable future.

O-4411-03

Environmental Justice and Conceptions of the Green Economy

T. Ehresman (1) ; C. Okereke (2)

(1) University of the South—Sewanee, Department of Politics, Sewanee, Tennessee, United States of America; (2) University of Reading, Reading, United Kingdom

Abstract: Green economy has become one of the most fashionable terms in global environmental public policy discussions and forums. Despite this popularity, and its being selected as one of the organizing themes of the United Nations Rio+20 Conference in Brazil, June 2012, its prospects as an effective mobilization tool for global environmental sustainability scholarship and practice remain unclear. A major reason for this is that much like its precursor concepts such as environmental sustainability and sustainable development, green economy is a woefully contested, with lengthening, yet ultimately unresolved debates over visions, actors and policies best suited to secure a more sustainable future for all. In this review article, we aim to fill an important gap in scholarly suggesting various ways in which green economy may be organized and synthesized as a concept, and especially in terms of its relationship with the idea of social and environmental justice. Accordingly, we offer a systemization of possible interpretations of green economy mapped onto a synthesis of existing typologies of environmental justice. This classification provides the context for future analysis of which, and how, various notions of green economy link with various conceptions of justice.

O-4411-04

Greenovation and Sustainable Manufacturing: A Case Study of the Chemical and Pharmaceutical Industry in Nigeria

J. Adedogan (1) ; OJ. Professor Adefgan (2)

(1) Global Network for Environment and Economic Development, Research, Department of Environment and Sustainable Development, Ibadan, Oyo State, Nigeria, Federal Republic of; (2) Lead City University, Economics, Ibadan, Oyo State, Nigeria, Federal Republic of

Addressing a paucity of research about industrial adoption of green innovation in Africa and, more generally, in tropical developing countries, we examined the Nigerian chemical and pharmaceutical industries. Qualitative interviews with one hundred and forty upper echelon executives representing thirty five Nigerian firms, challenged central conceptions that energy intensive industries in developing markets operate amid highly pollution-intensive conditions, within weak or non-existent formal environmental regulatory frameworks, and with limited institutional capacity. Our findings suggest a strong positive relationship between green innovation and financial performance and positive relationship between green innovation and sustainable manufacturing of African firms.

O-4411-05

Impacts of mitigation policies on labor markets and welfare

C. Grottera (1) ; W. Wills (2)

(1) COPPE/UFRJ, Energy planning, Rio de Janeiro, Brazil; (2) COPPE/UFRJ, Energy Planning, Rio de Janeiro, RJ, Brazil

The increasing need to reduce GHG emissions gives rise to new environmental regulations and market instruments, which present the potential to transform economies over the next decades. Production and consumption patterns are about to experience major changes as the world’s carbon emissions must decrease in order to meet safe carbon concentration levels in the atmosphere.

The transition to a low carbon economy offers many opportunities to create green and decent jobs in developing countries, especially in sectors related to renewable energy, sustainable agriculture, forestry and waste management. Meanwhile, sectors like oil and gas, mining and energy-intensive industry may experience significant losses.
Since sectors differ in labor skill requirements and remuneration levels, shifting to this new profile will have major implications for workers among various sectors. To the extent that this affects workers’ income, changes in inequality and poverty levels are expected. In that sense, some regions may require a fair transition and the preservation of decent jobs is arguably necessary.

This work uses a hybrid Computable General Equilibrium model (INTEC-LBR) to assess the impacts of mitigation options in various sectors, ranging from AFOLU to waste management, energy and industry sectors. The model is divided in 6 energy sectors, 7 industrial sectors, apart from the agriculture and livestock, transport and services sectors, and represents the Brazilian economy for a 25-year period, from 2005 to 2030.

The household sector is divided in 3 income classes, according to the their total income measured in base-year minimum wages (2005). Household consumption and income levels were calibrated using the 2003 National Household Budget Survey (POF), undertaken by the Brazilian Institute of Geography and Statistics (IBGE). The first income class represents the 16% poorer households, the second the 60% intermediary ones, and the third class represents the 24% richest households

The long-term scenarios depicted in the study were built through a participative process that engaged more than 70 stakeholders from different areas, including government, private sector, the scientific community and civil society agents. In order to simulate quite ambitious mitigation scenarios, a set of mitigation options was identified, contemplating possibilities in the AFOLU, industrial, transport, residential and services, energy and waste sectors. The inputs provided by the stakeholders and sectorial experts included different mitigation options, investment requirements, GHG abatement potential and marginal abatement costs, among other aspects.

After defining a set of mitigation options, stakeholders were interested in checking what would be the influence of the implementation policy over macroeconomic and social indicators. To assess those effects, two implementation policies were tested – a normative scenario (command and control) and a normative scenario plus a carbon tax (100 US$/tCO2e).

Since several of those options present low and even negative abatement costs, our results show that their implementation do not jeopardize total output and jobs, even though there are winners and losing sectors. For example, jobs in oil, coal and carbon intensive sectors decrease whilst jobs in the biomass and services sectors increase. The former usually employs high-skilled labor, while workers in the latter are usually less skilled. Therefore, we can conclude that a greater evolution in poor workers’ income, relative to high-skilled ones, leading to a better income distribution in the long run.

O-4411-06
Low Carbon Economy versus Ecological Civilisation: Polarization and Consensus of China’s environmentalism
C. Coron (1)

(1) Department of Politics and International Studies, University of Warwick, Coventry, UK, United Kingdom

China’s Climate Strategy proclaims the ultimate objective to transform its economic mode towards “green and low carbon development” (lvse ditan fazhan) (China Climate Strategy 2014—2020). This strategy is often equated with the concept of “green growth”, which the Chinese government has sponsored in the past 10 years, mirroring its success in becoming the world’s largest manufacturer of green technologies (REN report 2013) and the world’s largest “green market” (IGEA, 2014[1]). Indeed, both concepts emphasise the bottom line economic quests for growth, and hence are often seen as a “growth ban” and on the contrary can be a motor of economic growth (Pan, J. et al, 2010; Jacobs, M. 2013).

However, this economic interpretation of sustainability, and the market-oriented policies it entails, have been challenged, not only internationally, but also within China. In my paper, I brings evidence of this domestic debate and assess the relative importance, within it, of “green growth” as enabling and inhibitor of actions against climate change. Based on an extensive review of Chinese media, NGOs and academic publications, as well as policy documents, I discuss how issues of principle have informed two “low carbon policies”: the introduction of carbon markets and the promotion of “low carbon cities” in the 12th Five-Year-Plan (2011—2016).

I argue that the rhetoric of “low carbon development” has served mainly to cut through a polarized debate regarding the responsibility for the provision environmental public goods in China. Amongst them, nationalists still view “Low Carbon” as a western plot to contain China’s rise (Gou, 2010)[2] and blame foreign capitalists for destroying China’s resources and public health for the benefit of western consumers (Wen, Dale, 2015). On the contrary, socialists interpretations of the concept of “ecological civilization” (Shengtai wenming), which was included in the Constitution of the Communist Party in November 2012, target the government as principal agent of change, and reject the focus on economic growth as corrupted and ‘western’ (Yu, Keping, 2003; Pan, Yue, 2007)[4]. But as implementing successful climate actions in China remains contingent on strong government support, success relies on creative accommodation of the official rhetoric of balancing economic and environmental priorities.

[3] «The Party must promote all-around economic, political, cultural, social and ecological modernization progress in accordance with the overall plan for the cause of socialism with Chinese characteristics.»

Co-performance: the making of ecological modernization theory and EU climate politics
S. Aykut (1) ; B. Gabrielle (2)

(1) LISIS, Université Paris—est, Marne-la-Vallée, France; (2) Irstea, Cestas , France

Scholars in comparative political science generally acknowledge that the European Union took the lead in environmental protection and in global climate politics in the late 1990s. They attribute the legislative and diplomatic activism of the European Union in environmental issues to the prevalence of ecological modernization beliefs within the European Commission and some Member States heralded as leaders in this domain (Weale 1992; Pridham and Cini 1994; Cini 1995; Hajer 1995; Weale, Priddham et al. 2000). Taking the EU as an example, this contribution aims at questioning the role of norms and beliefs in the development of ambitious climate policy by (supra-)state actors.

We argue that ecological modernization discourse and EU environmental politics co-evolved and co-produced a narrative of environmental performance. This occurred through a twofold process: (1) ecological modernization is not only a discourse but a narrative with performative consequences; (2) the evolution of EU climate policy shaped the development of ecological modernization theory. The first narrative emerged into a political context within which the discourse on ecological modernization became an influential narrative in the EU environmental politics. We situate this context in the post—cold war history of transatlantic relations. We then relate ecological modernization became an influential narrative in the EU environmental politics. We situate this context in the post-cold war history of transatlantic relations. We then relate ecological modernization to the EU’s climate politics in the late 1990s. The contribution argues that ecological modernization discourse and EU climate policies contributed to the development of relatively inclusive narratives of climate governance.
**K-4412-01**

**Why We Should Make RICE NICE: The Importance of Intragenerational Inequalities for the Economics of Climate Change**

M. Fleurbaey (1) ; M. Budolfson, (2) ; F. Dennig (2) ; A. Siebert, (3) ; R. Socolow (4)

(1) Princeton University, Woodrow Wilson School, Princeton, United States of America; (2) Princeton University, Uchv/wws, Princeton, New Jersey, United States of America; (3) Princeton University, Climate futures initiative, Princeton, New Jersey, United States of America; (4) Princeton University, Mechanical engineering, climate futures initiative, Princeton, New Jersey, United States of America

RICE and leading IAMs focus on aggregate economic growth, which has the effect of downplaying important detrimental effects of climate change on the poorest populations. In this paper we introduce a variant of the RICE model in which income distributions at a sub-regional level are modeled. We call the new model NICE, for Nesting Inequalities, Climate and Economy. By reframing the model with the above income disaggregation (in our case into income quintiles), we strive to address these issues of temporal urgency and intraregional equity more thoroughly.

When the degree of inequality aversion (embodied in the elasticity of marginal utility) is increased in RICE, the prescribed mitigation effort is reduced quite significantly. The underlying reason is the Ramsey equation:

\[ \text{discount rate} = \text{pure time preference} + \text{inequality aversion} \times \text{growth rate}. \]

With the positive (and often significant) growth rates of such models, an increase in the elasticity simply leads to more discounting.

However, if inequality aversion is a good reason to discount future damages to wealthier individuals relative to equivalent mitigation costs, to the less affluent present, it should also be a good reason to be more concerned about damages (and costs) to poorer individuals than richer individuals, regardless of the time in which they take place.

In NICE sub-regional income distributions are explicitly modeled. We combine these with several point estimates from the literature on the distribution of climate damages across income groups. Once these are incorporated, the picture of the richer future benefitting from the effort of the relatively poor present disappears. We find that for some reasonable damage distributions the poorest income groups in some regions could be worse off than their predecessors even under the low damage estimates from the IAM literature. The effect on the policy prescription is that much more aggressive mitigation is warranted to avoid damaging those vulnerable groups. Furthermore, the effort is increasing in the degree of inequality aversion in the social objective for some damage assumptions.

Explicit incorporation of distributional concerns in the evaluation of a public good such as climate change mitigation can be criticized for making an inefficient use of policy instruments. Ideally, the public good should be provided considering aggregates, and distributional concerns dealt with by more efficient redistributive policies. We consider such a possibility in NICE, and find that the redistributive policies required to substitute for the strong mitigation policy are well beyond what can be considered politically feasible. If income redistribution from rich to poor is performed within regions (with no transfers across regions), an additional 65% marginal tax rate would have to be levied and redistributed in order to alleviate the same (modeled) economic damages to the poor as might be alleviated by the welfare optimal mitigation rate. We also examine transfers between regions. “Overseas” aid from other regions would have to be particularly efficient at targeting only the poor to be an adequate substitute at all, and even so, it would have to be significantly greater than currently accepted levels.

**K-4412-02**

**The climate responsibilities of industrial carbon producers**

P. Frumhoff (1) ; R. Heede (2) ; N. Oreskes (3)

(1) Union of Concerned Scientists, Cambridge, MA, United States of America; (2) Climate Accountability Institute, Snowmass, CO, United States of America; (3) Harvard University, Department of the history of science, Cambridge, MA, United States of America

Responsibility for climate change lies at the heart of societal debate over actions to address it. The United Nations Framework Convention on Climate Change (UNFCCC) established the principle of «common but differentiated responsibilities» among nations, suggesting that industrialized nations that had produced the greatest share of historic emissions bore particular responsibility for preventing dangerous interference with the climate system.

But climate responsibilities can be distributed in other ways as well. Here, we consider the distinctive responsibilities of the major investor-owned producers of fossil fuels assessing the actions these companies took and could have taken to act upon the scientific evidence of climate change.

Recently published data show that just 90 entities have produced the fossil energy responsible for 63 percent of the world’s industrial emissions of CO2 and methane; of these 90 are investor-owned companies. As the scientific evidence became clear, many of these companies sought to doubt about the science linking their products to global warming, and today are seeking new and increasingly carbon-polluting sources of fossil fuels.

We conclude that major investor-owned fossil energy companies carry significant responsibility for climate change. It is still possible for these companies to effectively contribute to a solution. Significant progress in reducing emissions and limiting climate change could be achieved if companies 1) unequivocally communicate to the public, shareholders, and policymakers of the climate risks resulting from continued use of their products, and therefore the need for restrictions on greenhouse gas emissions consistent with the 2 °C global temperature target; 2) firmly reject contrary claims by industry trade associations and lobbying groups; and, 3) accelerate their transition to the production of low-carbon energy.

Evidence from history strongly suggests that a heightened societal focus on their climate responsibilities may hasten such a transition.

**K-4412-03**

**Equity, Justice, and Security in Global Climate Governance**

D. Michel (1)

(1) The Stimson Center, Environmental Security Program, Washington, DC, United States of America

Global climate change presents the international community with a seemingly intractable collective action problem. Growing greenhouse gas emissions are projected to raise global temperatures, shift precipitation patterns, and increase extreme weather events. The emerging repercussions of climate changes already underway threaten the livelihoods and security of countries and communities everywhere. Both the drivers and the impacts of transcend traditional state boundaries and governance structures. No single state can counter or avert the impacts of climate change on its own. But a country’s efforts to reduce its emissions shares the climate benefits with every other nation while bearing the cost of taking action alone. Those states which do nothing to combat climate change can “free ride” on the efforts of those that do. The
UNFCCC has become the global platform for international negotiations, where nearly 200 sovereign states. But ongoing debates over the effectiveness and equity of mitigation measures, adaptation technologies, and funding suggest the need for a new evaluation. The future of greenhouse governance depends on innovation towards new types of climate regime. Does the architecture of universal agreement constitute the way forward, or are other channels more suited for climate action? Can the emerging landscape open fruitful potential options and practices for advancing more effective climate governance? Can new governance mechanisms simultaneously ensure climate security and justice, efficiency and accountability, technology innovation and dissemination, or must decision makers and stakeholders inevitably navigate trade-offs between these goals.

In preparation for the 70th anniversary of the United Nations in 2015, The Hague Institute for Global Justice and The Stimson Center have convened a high-level Commission on Global Security, Justice & Governance, to enhance global understanding and capacity and to advance practical recommendations for innovative collaborative action to address critical global challenges such as climate change. Co-chaired by former US Secretary of State Madeleine Albright and former Foreign Minister Ibrahim Gamba of Senegal, the commission members include Yoriko Kawaguchi, former Foreign Minister of Japan; Shyam Saran, former Foreign Secretary and chief climate negotiator of India; and Erna Wulf-Mathiesen, former Minister of Foreign Affairs and Minister of the Environment of Denmark, and Sheh Nazirullah, former Minister of Foreign Affairs of Pakistan. The Commission will conclude its report in June 2015. This contribution will provide the opportunity to present and discuss the Commission’s analysis and recommendations.

A novel approach for analysing how equitable and ambitious countries’ national policy actions and targets are in the light of the forthcoming Intended National Determined Contributions (INDCs)

**O-4412-01**

Quantifying Development Needs: An energy centered approach to climate justice

N. Rao (1) ; W. Lamb (2)

(1) IIASA, Energy, Laxenburg, Austria; (2) Tyndall Centre for Climate Change Research, School of Mechanical, Aerospace and Civil Engineering, University of Manchester, Manchester, United Kingdom

Despite the vast literature on global climate justice, there is a surprising lack of studies that attempt to quantify the emissions impact of basic human development, even though many of these frameworks aim, either implicitly or explicitly, to shield basic human development from the costs of mitigation. [1] Broadly, the literature that frames distributive justice in terms of emissions rights neglects to relate these rights to development needs, making them susceptible as claims of ‘hot air’. Proposals that aim to differentiate nations’ capacity to mitigate define relatively arbitrary, universal thresholds of exemption, [2] typically in terms of income [3] or emissions, which ignore the heterogeneity in countries’ energy sectors, and consequently their mitigation costs. [4] Yet, achieving climate stabilization at 450 ppm or less would significantly restrict global growth in per capita energy demand, and no current strategy for re-evaluation. The future of greenhouse governance among nearly 200 sovereign states, but ongoing debates over the effectiveness and equity of mitigation measures, adaptation technologies, and funding suggest the need for a new evaluation. The future of greenhouse governance depends on innovation towards new types of climate regime. Does the architecture of universal agreement constitute the way forward, or are other channels more suited for climate action? Can the emerging landscape open fruitful potential options and practices for advancing more effective climate governance? Can new governance mechanisms simultaneously ensure climate security and justice, efficiency and accountability, technology innovation and dissemination, or must decision makers and stakeholders inevitably navigate trade-offs between these goals.

In preparation for the 70th anniversary of the United Nations in 2015, The Hague Institute for Global Justice and The Stimson Center have convened a high-level Commission on Global Security, Justice & Governance, to enhance global understanding and capacity and to advance practical recommendations for innovative collaborative action to address critical global challenges such as climate change. Co-chaired by former US Secretary of State Madeleine Albright and former Foreign Minister Ibrahim Gamba of Senegal, the commission members include Yoriko Kawaguchi, former Foreign Minister of Japan; Shyam Saran, former Foreign Secretary and chief climate negotiator of India; and Erna Wulf-Mathiesen, former Minister of Foreign Affairs and Minister of the Environment of Denmark, and Sheh Nazirullah, former Minister of Foreign Affairs of Pakistan. The Commission will conclude its report in June 2015. This contribution will provide the opportunity to present and discuss the Commission’s analysis and recommendations.

A novel approach for analysing how equitable and ambitious countries’ national policy actions and targets are in the light of the forthcoming Intended National Determined Contributions (INDCs)

**O-4412-01**

**A novel approach for analysing how equitable and ambitious countries’ national policy actions and targets are in the light of the forthcoming Intended National Determined Contributions (INDCs)**

MR. Rocha (1) ; N. Höhne (2) ; H. Fekete, (2) ; B. Harre (1) ; M. Schaeffer, (1) ; M. Hagemann, (2) ; ML. Jeffery (3) ; J. Gütschow (3) ; F. Sferra (1) ; Y. Deng (4) ; K. Wouters, (4) ; BP. Van (4) ; F. Comaty (4) ; K. Blok (4)

(1) Climate Analytics, Berlin, Germany; (2) NewClimate Institute, Cologne, Germany; (3) Potsdam Institute for Climate Impact Research, Potsdam, Germany; (4) Econys, Cologne, Germany

Countries are currently working on preparing measures to conquer climate change at many frontiers. They are developing policies that will lead to emission reductions in the short and medium term, they are considering and implementing emission reduction targets that provide guidance for policy-makers and stakeholders, and they are preparing submissions to the UNFCCC, in the form of Intended National Determined Contributions (INDCs), committing to legally-binding targets (e.g., emissions reductions below base year) for the post-2020 period. The sum of the initially proposed national actions at a global level so far falls short of what is required to keep global warming below 2°C, to agree on and coordinate climate policies from the broad range of possible ‘principles’ that could be agreed on to effect sharing. With the goal of extracting a unified benchmark system from the various approaches and categories for countries, we used these ‘principles’ to develop a framework that enables the rating of countries’ current level of effort against their fair level of effort (FLE) sharing categories. In addition the framework takes account of countries’ mitigation potentials and aspects such as finance provided and the conditionality of targets on external parameters. For each category, we introduced that describe the countries’ overall effort level: inadequate, medium, sufficient and role model.

Under this proposed framework, the ambition of a large number of countries that have put forward targets so far are rated as inadequate or medium according to the scale developed here. One of the major emitters, China, has pledged to peak emissions no later than 2030. The Climate Action Tracker quantifies resulting emissions of up to 15Gt in 2030, and rates this as inadequate, as only the least stringent effort sharing category is achieved at this level. The currently announced target of the USA of 26 – 28% below 2005 in 2025 results in a rating of medium, meaning that this target is within the range of a number of effort-sharing categories, but the level of ambition would only be sufficient at the global level, if other countries moved into the more ambitious end of their effort sharing ranges. The submitted INDC of the EU of reducing emissions by 40% below 1990 levels in 2030 receives the rating inadequate. Effort sharing approaches demand ambitions in the range of the EU, in order for it to contribute in a fair manner to the global target.

**O-4412-02 Quantifying Development Needs: An energy centered approach to climate justice**

N. Rao (1) ; W. Lamb (2)

(1) IIASA, Energy, Laxenburg, Austria; (2) Tyndall Centre for Climate Change Research, School of Mechanical, Aerospace and Civil Engineering, University of Manchester, Manchester, United Kingdom

Despite the vast literature on global climate justice, there is a surprising lack of studies that attempt to quantify the emissions impact of basic human development, even though many of these frameworks aim, either implicitly or explicitly, to shield basic human development from the costs of mitigation. [1] Broadly, the literature that frames distributive justice in terms of emissions rights neglects to relate these rights to development needs, making them susceptible as claims of ‘hot air’. Proposals that aim to differentiate nations’ capacity to mitigate define relatively arbitrary, universal thresholds of exemption, [2] typically in terms of income [3] or emissions, which ignore the heterogeneity in countries’ energy sectors, and consequently their mitigation costs. [4] Yet, achieving climate stabilization at 450 ppm or less would significantly restrict global growth in per capita energy demand, and no current strategy for re-evaluation. The future of greenhouse governance among nearly 200 sovereign states, but ongoing debates over the effectiveness and equity of mitigation measures, adaptation technologies, and funding suggest the need for a new evaluation. The future of greenhouse governance depends on innovation towards new types of climate regime. Does the architecture of universal agreement constitute the way forward, or are other channels more suited for climate action? Can the emerging landscape open fruitful potential options and practices for advancing more effective climate governance? Can new governance mechanisms simultaneously ensure climate security and justice, efficiency and accountability, technology innovation and dissemination, or must decision makers and stakeholders inevitably navigate trade-offs between these goals.

In preparation for the 70th anniversary of the United Nations in 2015, The Hague Institute for Global Justice and The Stimson Center have convened a high-level Commission on Global Security, Justice & Governance, to enhance global understanding and capacity and to advance practical recommendations for innovative collaborative action to address critical global challenges such as climate change. Co-chaired by former US Secretary of State Madeleine Albright and former Foreign Minister Ibrahim Gamba of Senegal, the commission members include Yoriko Kawaguchi, former Foreign Minister of Japan; Shyam Saran, former Foreign Secretary and chief climate negotiator of India; and Erna Wulf-Mathiesen, former Minister of Foreign Affairs and Minister of the Environment of Denmark, and Sheh Nazirullah, former Minister of Foreign Affairs of Pakistan. The Commission will conclude its report in June 2015. This contribution will provide the opportunity to present and discuss the Commission’s analysis and recommendations.
This work builds on a forthcoming publication in Global Environmental Change [6] and presents preliminary insights from research commencing shortly as part of a European Research Council (ERC) Starting Grant entitled ‘Decent Living Energy: energy and emissions thresholds for providing decent living standards to all’.


The climate-pension deal

N. Jaakolai (1) ; F. Dennig (2) ; VB. David (3)

(1) Ifo Institut, Munich, Germany; (2) Princeton University, Uchv/wws, Princeton, New Jersey, United States of America; (3) Copenhagen Economics, Copenhagen, Denmark

‘Reducing carbon emissions is costly for current generations, and only benefits people living in the far future. Claims like this are common in the popular discourse on climate policy. However, they are mistaken: it is well known that, with overlapping generations, the beneficiaries of climate policies (future generations) can compensate those undertaking the effort (current generations).’ Other words, there exist climate policies that tackle the externality and leave everybody better off.

What is required for this is a ‘climate–pension deal’. Such a deal involves current generations reducing emissions, while pension adjustments shift the benefits of abatement from future generations to the present, as compensation for the abatement costs. This compensation ensures that consumption of the current generations does not fall, and may even increase. In this way current generations are not made worse off, even if they don’t live long enough to experience the climate benefits. The counterpart of the pension transfers is lower investments in physical capital, which in effect, the portfolio of saving is allocated from (private) physical capital to (public) natural capital.

We characterise the required ‘climate–debt deal’ which moves society to some Pareto-efficient point. Using an overlapping–generations model, augmented with a climate economy, we assess intergenerational distributional consequences of Pareto-improving climate policies and compare the fiscal burden due to the required transfers to existing debt and pension burdens. In this way, we assess whether intergenerational compensation is a ‘big deal’ or not.

We also propose a new framework to assess the distributional consequences of climate policy options. Typically, Pareto-efficient points are obtained using a social welfare function. A common choice is the weighted utilitarian sum, often with discount factors as weights. These weights are an opaque device, difficult to relate to the distributional consequences.

We propose an alternative which focuses on the distributional consequences. Efficient climate policy generates a surplus: we employ the idea of intergenerational bargaining over how this surplus is distributed over the business-as-usual outcome even amongst themselves. Alternative bargaining outcomes incorporate the effect of sunk investments and split the surplus in favour of future generations. Recognizing that compensation for past investments may not be politically achievable. We present and compare several alternative bargaining notions, all of which share the feature that all generations must benefit from the bargain. We also consider an overlapping generations model of a dynamic, finite-lived agent economy and compare the results of our intergenerational bargains with those resulting from typical assumptions in the integrated assessment literature.[1]

In addition to assessing the magnitude of the flow of intergenerational compensation involved in efficient climate policies, our results imply that the intergenerational distributional effects of climate policy can be corrected for, and are thus a secondary issue compared to questions about the international burden-sharing.[2]

References:

Quantification of Effort-Sharing Principles: Policy Choices and Data Uncertainty

ML. Jeffery (1) ; Y. Robiou Du Pont (2) ; M. Meinshausen, (3) ; J. Gütschow (1)

(1) Potsdam Institute for Climate Impact Research, Potsdam, Germany; (2) Australian–German College of Climate & Energy Transitions, University of Melbourne, Melbourne, Australia; (3) University of Melbourne, Australian–german college of climate & energy transitions, school of earth sciences, Melbourne, Australia

A fundamental principle of the UNFCCC negotiations is that of Common But Differentiated Responsibilities and Respective Capabilities (CBDR-RC). Operationalizing this principle remains a core challenge in the development of a new international agreement, in part due to the nuances of national circumstances, which cannot be readily resolved without negotiation. However, the scientific and non-governmental community can contribute by providing quantitative interpretations of effort-sharing proposals in terms of emission mitigation targets and financial contributions.

Previous quantifications of burden-sharing proposals differ significantly, and a collation of existing studies identified a wide range of values for the fair-share allocation. Typically, these differences are due to differences in the fundamental underlying principle used to determine the fair-share distribution of emissions, or a convergence toward equal per capita emissions. The ranges in reduction targets are partly due to differences in the underlying principle used to determine the fair-share distribution of emissions, or a convergence toward equal per capita emissions. Moreover, the ranges also result from different choices made in the method of quantification, e.g., using climate scenarios, underlying data, and assumptions regarding future emissions growth and socioeconomic development.

These differences in data and key assumptions compound any comparison of results or understanding of the key factors determining fair-share allowances.

Using the PRIMAP (Potsdam Real-time Integrated Model for probabilistic Assessment of emissions Paths) Emissions Module we generate and assess a suite of effort-sharing scenarios resulting from multiple policy and data options within the Greenhouse Development Rights effort–sharing regime (Baer et al., 2008). The Greenhouse Development Rights regime requires emissions, GDP, and population data projections, and incorporates multiple policy options, thereby providing a consistent framework for comparing these factors. We generate the effort-sharing scenarios using emissions projections from the IPCC AR5 and LUMIT databases, and socioeconomic data from the Shared Socioeconomic Pathways (SSPs) developed for the IPCC 5th Assessment, all downscaled to the national level.

The generated scenarios are assessed in terms of the following factors: 2025 and 2030 mitigation targets for individual countries and regions. We identify the key factors that make a quantitative difference in a country’s fair-share mitigation target. Analysis of these factors allows the identification of areas of convergence and divergence from the perspective of different policy options, and the underlying effort-sharing principles.

Using the suite of effort-sharing scenarios, we explore several key policy questions. Including: What is the difference in ambition required for a 1.5°C or 2°C limit in global temperature change? For a given country, does the access to historical cumulative emissions and capabilities lead to a greater impact on the fair-share allocation? What does it mean for 2030 mitigation targets if pre-2020 ambition is not increased? From a quantitative perspective, which of these issues is the most important?

Finally, we highlight how quantification methods can be improved to minimize the impact of data and scenario projection uncertainty on the evaluation of fairly distributed emissions targets.

References:
Höhne, N., M. den Elzen, and D. Escalante (2014)
Global Climate Ethics: A View Based on Chinese Philosophy

X. Liu (1) ; Z. Wang (2) ; J. Wu (2)
(1) management institute of shenzhen university, shenzhen, China; (2) Institute of Policy and Management, Chinese Academy of Sciences, Beijing, China

The Ethical Factors have been recognized now in the scientific researches on the Climate Change. These researches can be more efficient and effective when studies on economic realities and ethic contexts are involved. Referring the Chinese traditional ethic values, this essay introduces a new Climate Ethic System applicable to inter-nation discussions, with pursuit of “harmony” and the Rawke principle on “operation on ranking and grouping”. It probes into the assessment principles of Climate Ethics—Equity, Justice and wellbeing based on the explication of the ethic connotations of Justice and Equity in the Chinese Philosophy, and further into the justice in climate negotiations. As an ethic principle for the international climate negotiations, this essay suggests: all the measures against the Climate Change should keep in line with the social and economic development of all the participating countries, paving the way for the Pareto improvements in each participant while reducing the gaps among them, without depressing the social individuals, which are being poor, deeper into poverty.

Intergenerational equity under catastrophic climatic change

A. Méjean (1) ; S. Zuber (2) ; M. Fleurbaey (3) ; A. Pottier (1)
(1) CIRED, Nogent-sur–Marne, France; (2) Paris School of Economics, Paris, France; (3) Princeton University, Woodrow Wilson School, Princeton, United States of America

Climate change raises the issue of intergenerational equity, as catastrophes may unfairly affect some generations. As catastrophic risk thwarts human rights and desirable impacts (IPCC, 2014), possibly leading to economic collapse, the tradeoff is no longer between present and future consumption, but between present consumption and the possible future extinction of civilization (Weitzman, 2009). This paper aims at identifying public policies that account for the distribution of utilities, (ii) satisfy the Pareto principle (i.e. it should account for inequality aversion of the social planner and respects a weak form of Pareto, but is not separable under risky prospects (but we will not consider past generations in our analysis)) criterion includes a critical level of consumption which can be interpreted as the level of subsistence.

In order to reveal the impact of inequality aversion on optimal climate policy, we consider various isoelastic functions \( \phi \), which translate the inequality aversion of the social planner, and various isoelastic functions \( u \), which translate the risk aversion of the social planner. Inequality aversion here relates to the degree of inequality aversion of the social planner and respects a weak form of Pareto, but is not separable under risky prospects (but we will not consider past generations in our analysis). This criterion includes a critical level of consumption which can be interpreted as the level of subsistence.

We use an integrated assessment model which simulates the future joint evolution of the economy and the climate. The RESPONSE model is a dynamic optimization model (Pottier et al., 2015), which belongs to the tradition of compact integrated assessment models such as DICE. It combines a Ramsey–like macroeconomic module and a climate module, and can be used to determine the optimal climate objective by comparing mitigation costs and avoided climate damages. We account for the risk of extinction due to climate change, first by assuming an exponential function for the extinction probability that depends on the temperature and on the level of economic output. We assume that the extinction probability of species increases with warming and that for a given level of climate change there will be a lower probability of extinction under a given level of climate change.

Integrated assessment models can reveal the policy implications of various normative choices through the use of social welfare functions. Ideally, social welfare criteria should (i) account for inequality aversion (it should thus differ from the utilitarian criterion, which does not account for the distribution of utilities), (ii) satisfy the Pareto principle (i.e. it should account for inequality aversion of the social planner and respects a weak form of Pareto, but is not separable under risky prospects (but we will not consider past generations in our analysis)) criterion includes a critical level of consumption which can be interpreted as the level of subsistence.

In order to reveal the impact of inequality aversion on optimal climate policy, we consider various isoelastic functions \( \phi \), which translate the inequality aversion of the social planner, and various isoelastic functions \( u \), which translate the risk aversion of the social planner. Inequality aversion here relates to the degree of inequality aversion of the social planner and respects a weak form of Pareto, but is not separable under risky prospects (but we will not consider past generations in our analysis). This criterion includes a critical level of consumption which can be interpreted as the level of subsistence.

We use an integrated assessment model which simulates the future joint evolution of the economy and the climate. The RESPONSE model is a dynamic optimization model (Pottier et al., 2015), which belongs to the tradition of compact integrated assessment models such as DICE. It combines a Ramsey–like macroeconomic module and a climate module, and can be used to determine the optimal climate objective by comparing mitigation costs and avoided climate damages. We account for the risk of extinction due to climate change, first by assuming an exponential function for the extinction probability that depends on the temperature and on the level of economic output. We assume that the states of the world where people are wealthy will show enhanced resilience to climate damages, and will therefore face a lower probability of extinction under a given level of climate damages.

Integrated assessment models can reveal the policy implications of various normative choices through the use of social welfare functions. Ideally, social welfare criteria should (i) account for inequality aversion (it should thus differ from the utilitarian criterion, which does not account for the distribution of utilities), (ii) satisfy the Pareto principle (i.e. it should account for inequality aversion of the social planner and respects a weak form of Pareto, but is not separable under risky prospects (but we will not consider past generations in our analysis)). This criterion includes a critical level of consumption which can be interpreted as the level of subsistence.

In order to reveal the impact of inequality aversion on optimal climate policy, we consider various isoelastic functions \( \phi \), which translate the inequality aversion of the social planner, and various isoelastic functions \( u \), which translate the risk aversion of the social planner. Inequality aversion here relates to the degree of inequality aversion of the social planner and respects a weak form of Pareto, but is not separable under risky prospects (but we will not consider past generations in our analysis). This criterion includes a critical level of consumption which can be interpreted as the level of subsistence.

We use an integrated assessment model which simulates the future joint evolution of the economy and the climate. The RESPONSE model is a dynamic optimization model (Pottier et al., 2015), which belongs to the tradition of compact integrated assessment models such as DICE. It combines a Ramsey–like macroeconomic module and a climate module, and can be used to determine the optimal climate objective by comparing mitigation costs and avoided climate damages. We account for the risk of extinction due to climate change, first by assuming an exponential function for the extinction probability that depends on the temperature and on the level of economic output. We assume that the states of the world where people are wealthy will show enhanced resilience to climate damages, and will therefore face a lower probability of extinction under a given level of climate damages.

Integrated assessment models can reveal the policy implications of various normative choices through the use of social welfare functions. Ideally, social welfare criteria should (i) account for inequality aversion (it should thus differ from the utilitarian criterion, which does not account for the distribution of utilities), (ii) satisfy the Pareto principle (i.e. it should account for inequality aversion of the social planner and respects a weak form of Pareto, but is not separable under risky prospects (but we will not consider past generations in our analysis)). This criterion includes a critical level of consumption which can be interpreted as the level of subsistence.

In order to reveal the impact of inequality aversion on optimal climate policy, we consider various isoelastic functions \( \phi \), which translate the inequality aversion of the social planner, and various isoelastic functions \( u \), which translate the risk aversion of the social planner. Inequality aversion here relates to the degree of inequality aversion of the social planner and respects a weak form of Pareto, but is not separable under risky prospects (but we will not consider past generations in our analysis). This criterion includes a critical level of consumption which can be interpreted as the level of subsistence.
The contribution of emissions traced to major carbon producers to changes in meteorological and health risks during extreme events

D. Mitchell (1); F. Otto (1); S. Sparrow (1); M. Allen (2); P. Frumhoff (3)

(1) University of Oxford, Oxford, United Kingdom; (2) University of Oxford, School of Geography and Environment and the Smith School of Enterprise and the Environment, Oxford, United Kingdom; (3) Union of Concerned Scientists, Cambridge, MA, United States of America

Recent studies have shown that ~63% of cumulative, world wide emissions of CO2 have come from only 90 major carbon producers (hereafter, "carbon majors"). Here, we use this result to model a hypothetical climate where the carbon majors never existed.

Specifically, we use a unique modelling capability to perform massive ensembles of climate model simulations ("climate prediction dot net - CPDN"), which enables assessment of any changing probabilities of particular meteorological extremes of interest. We use results from a sister study which compares scenarios representing the year 2003 (i.e. with only natural conditions; "scenario 1") and (ii) as it could have been, if humans had not altered atmospheric gas composition (i.e. with only natural conditions; "scenario 2").

A feature of CPDN is that each global simulation contains a high-resolution "nested" regional climate model centred on Europe. This high-resolution modelling capability allows us to perform much of the analysis at the city level. In our sister study we use Scenario’s 1 and 2, and show how heat-related mortality changed over Paris during 2003. In this study, we then discuss the implications for such a change given our Scenario 3, which involves only the 90 carbon majors.

Distributing the global RCP2.6 emissions: five versions of ‘fair’ country level allocations

Y. Robiou Du Pont (1); M. Meinshausen, (2); ML. Jeffery (3)

(1) Australian–German College of Climate & Energy Transitions, University of Melbourne, Melbourne, Australia; (2) University of Oxford, Australian–German college of climate & energy transitions, school of earth sciences, Melbourne, Australia; (3) Potsdam Institute for Climate Impact Research, Potsdam, Germany

Current climate negotiations under the United Nations Framework on Climate Change Convention (UNFCCC) aim to limit global warming to 2°C. The distribution of the corresponding greenhouse gas (GHG) mitigation burden amongst countries is a major block in progress toward an international agreement on binding commitments. Scientists and national experts have proposed and quantified several equity principles to distribute the international mitigation burden (Baer, Fieldman, Athanasiou, & Kartha, 2008; BASIC experts, 2011; Jacoby, Barbir, Petlir, & Reilly, 2008; Nabel et al., 2011). Studies modelling these principles distribute different GHG emissions of diverse global emissions pathways. However, these global emissions pathways may not correspond to national optima at optimal cost and result in different temperature responses making cross-studies comparisons difficult.

The distribution of the annual GHG emissions of a global cost optimal scenario has not yet been compared across a set of approaches representative of the international equity debate. The Fifth Assessment Report of the International Panel on Climate Change (IPCC AR5) introduced the Representative Concentration Pathway 2.6 (RCP2.6), a cost optimal pathway that has a likely (greater than 66%) chance of limiting global warming to 2°C (IPCC, 2013; Meinshausen et al., 2011). The international distributions of the emissions associated with RCP2.6 following different equity principles would provide decision makers with a consistent comparison. What sets of national GHG emission pathways would reflect the proposed equity principles while matching the physical emissions of RCP2.6, at each time step? What would then be the regional and national mitigation targets for 2025 and 2030 according to each effort sharing approach?

The IPCC AR5 presented regional 2030 mitigation targets collated from over forty studies and grouped into five categories according to the distributive justice concepts applied: ‘equality’, ‘equal cumulative per capita’ ‘responsibility’, ‘need’, ‘capability’, and ‘staged approaches’ (IPCC WGI, 2014). We model five approaches representative of these five categories using the PRIMAP (Potsdam Real-time Integrated Model for probabilistic Assessment of Mitigation) emissions Path World-Pathways (Nabel et al., 2011). Each of these approaches distributes the emissions of RCP2.6 amongst all UNFCCC parties. Consequently, the aggregation of the national emission pathways of each approach matches the emissions of RCP2.6 at each time step. For each approach, pathways are calculated for a range of parameters that account for transmission period to the allocation start, historical emissions, historical and projected population data, and GDP projections.

At the next Conference of the Parties (CoP) in December 2015, the international community aims to establish a binding agreement to limit climate warming. Parties to the UNFCCC should announce their Intended Nationally Determined Contributions (INDCs) ideally by March 2015. Our analysis informs the debate on equitable mitigation burden sharing amongst the international community. In particular, it should help decision makers and the public to appreciate the consistency between INDCs and the global goal of limiting warming to 2°C according to the various concepts of equity.

A Dynamic Interpretation of the Principle of Equity in the Next Climate Change Regime: Equity as a force of gravity

M. Rosa (1)

(1) University of Oslo, Pluricourts, Oslo, Norway

Equity will play a crucial role in designing the post-2020 climate change policy. The principle of equity is intrinsically tied to sustainable development as an expression of inter and intra-generational equity. The climate agreement has to be felt as equitable in order to be signed by a majority of country states. So far, climate Equity has been interpreted through the principle of Common but Differentiated Responsibilities and Respective Capabilities as encompassed in Art.3 UNFCCC. The current interpretation has brought the so-called firewall between developed and developing countries, where the first are bound to all the emission cuts. In the latest years some developing countries have become major emitters. The current division of mitigation efforts can therefore not be rested as equitable and could be changed. A dynamic treaty interpretation of the principle of equity could be one way to overcome this division.

This research demonstrates that the concept of equity should be interpreted dynamically because of its own intrinsic dynamism.

Since its early formulation in Art 38 of the ICJ’s Statute, equity principle has played a creative role in the public international law. Indeed core international law principles like pacta sunt servanda and unjust enrichment have arisen from equity concepts. One of the main questions acts as a force of gravity, dragging new contents into a treaty. In Climate discourse a dynamic approach to equity would highlight national circumstances rather than responsibility for the emissions. United Nations climate designing commitments. Equity dynamism calls also for flexibility and variety. The next Climate Agreement should be shaped as a flexible agreement in its contents, settings and outcomes. Mitigation commitments should be tailorable to what a country is willing and able to afford. This would bring different commitments to different countries.
This presentation will examine the main emission-reduction schemes proposed, aimed at implementing a dynamic interpretation of the equity principle. It will then analyze which of the features within the proposals the next Climate Change Agreement should include in order to be equitable. To date three approaches—the Global Carbon Budget Approach, the GDRs Framework and the Mutual Recognition Approach—have gathered momentum. Every approach has strengths and weakness from an equity perspective.

P-4412-10

Research on Global Carbon Emission Quotas Allocation in post-Kyoto Era

Q. Zhu (1); Z. Wang (2); J. Wu (2)
(1) China university of petroleum, Beijing, China; (2) Institute of Policy and Management, Chinese Academy of Sciences, Beijing, China

Abstract: By using the bottom–up and top–down modeling methods, this paper build a global model on quotas allocation. Through simulation, we draw the following four conclusions: (1) due to the difficulties of determining abatement way, benchmark year and proportion of reduction, current global carbon reduction programs exist uncertainty. (2) single principle of quota allocation can not satisfy preferences of all regions, and may even lead to extreme result of quotas allocation. (3) the weighted principle of quota allocation based on controlling the total emissions can be adopted in the future. (4) the weighted principle of quota allocation should cover as many principles of quotas allocation as possible; meanwhile the target of emissions reduction determined by climate negotiations should be replaced by the weight of principles from voting.

4413a - Technology, transformations and capabilities in developing countries

ORAL PRESENTATIONS

K-4413a-01

Building pro-poor, low carbon innovation systems through international and indigenous efforts

A. Ely (1) ; D. Ockwell (2)
(1) STEPS Centre, SPRU - Science Policy Research Unit, Sussex, United Kingdom; (2) University of Sussex, School of global studies, Brighton, United Kingdom

Local innovation capabilities have long been recognised as a key requirement in forging new innovation trajectories and low carbon development pathways. Building on the foundational literature from innovation studies, a swathe of research has highlighted the processes through which these have emerged at national levels, in particular in emerging technological nations such as China and India. In most of these cases, indigenous learning processes have led to the build-up of knowledge and capabilities within a usually small subset of elite firms.

At national levels (e.g. in the Chinese and Brazilian cases) the role of central policies and investment from strong development banks has combined with more local efforts to build innovation systems in poorer regions. Relatively few scholars have investigated the governance challenges associated with centralised policies and the sometimes divergent interests of provincial/ regional actors. At international levels, scholars have investigated the potential for collaborative research and development activities as a way of facilitating technology transfer and low carbon innovation.

Informed by some of these insights, international efforts are underway through the UNFCCC to try to provide external support for low carbon innovation of a transformative nature. In particular, the Climate Technology Centre and Network, as well as the Green Climate Fund, which claims transformative ambitions, promise to enhance developing countries’ low carbon innovation activities. ‘New donor nations’ may also play an important role (for example the BRICS banks). These efforts raise a fundamental question, echoing earlier innovation studies work that has pointed to the difficulties of purposive creation of innovation systems that have elsewhere emerged through complex indigenous interactions. How do international (donor) efforts co-ordinate with indigenous processes to foster the emergence of dynamic low carbon innovation systems?

This paper discusses some of the innovation systems literature that can inform our answers to these questions, especially the work of the Latin American school that has highlighted the challenges of implementing policies to build innovation systems that aim to emulate those that have emerged elsewhere. It will link to recent research carried out by the STEPS Centre around low carbon innovation capabilities and the role of ‘system builders’ in China and Sub-Saharan Africa. Linking this to the wider innovation studies literature raises questions for international processes that aim to foster innovation for alternative trajectories in low and middle-income countries.

O-4413a-02

The role of partnerships in enhancing the transfer and diffusion of climate change technologies

A. Abdel-Latif (1)
(1) ICTSD, Geneva, Switzerland

The decision to establish a Technology Mechanism (TM), at the Cancun conference in 2010, was an important milestone in efforts to advance the effective implementation of the technology transfer provisions of the United Nations Framework Convention on Climate Change (UNFCCC). Since then, the two bodies of the TM – the Technology Executive Committee (TEC), more akin to a policy body, and the Climate Technology Centre and Network (CTCN), the Mechanism’s operational arm – have begun to carry out their work and activities.

However, the role of partnerships in enhancing the transfer and diffusion of climate change technologies has not received significant attention in the process of the TM’s operationalization or in the work programs and activities of both the TEC and CTCN. Yet the mandates of both bodies include provisions to foster such partnerships. For instance, the mandate of the CTCN states that one
of its functions is “facilitating international partnerships among public and private stakeholders to accelerate the innovation and diffusion of environmentally sound technologies to developing country Parties.”

At the same time, recent years have witnessed a number of growing partnerships involving public and private entities, particularly in the context of bilateral clean energy and technology cooperation arrangements such as the US-China Renewable Energy Forum. These partnerships also address intellectual property rights (IPRs) in a pragmatic and constructive manner which could provide useful lessons for overcoming the polarized debate on this topic in the context of current climate negotiations.

The objective of this proposal would be to explore how can partnerships contribute to a strengthened TM that could be a possible basis for agreement on a technology package at COP 21 in Paris.

4413b - Environmental policies to enable innovation and transformation

ORAL PRESENTATIONS

K-4413b-01

Environmental policy, multinational firms and green innovation

J. Noailly (1); R. Smeets, (2)

(1) The Graduate Institute Geneva, Program «innovation, sustainable growth and technological change», Geneva, Switzerland; (2) Rutgers Business School, Newark, United States of America

This paper investigates the impact of environmental regulation on green innovation in a globalized world, where multinational firms locate production and R&D laboratories across several countries. Using firm-level data on multinational firms conducting green R&D both in developed and developing countries, we find that environmental regulation has a positive impact on clean innovation – in particular in countries where multinational firms face a pollution-haven motive, which is where firms locate their most dirty production processes. In other countries, other factors such as the wages of R&D workers and the country's absorptive capacity in green technologies seem to be more important triggers of clean innovation. Since multinational firms are a major channel for transferring technologies to developing countries, our results have implications for the design of policies aiming to promote the global diffusion of clean technologies.

O-4413b-01

Contextual Factors and Wind Energy Innovation Development — Comparing Germany, Denmark, China and India

Y. Dai (1); J. Nordensvard (2); A. Narain (3)

(1) Tsinghua University, School of Public Policy and Management, Beijing, China; (2) University of Southampton, Southampton, United Kingdom; (3) University of Maryland, Maryland, United States of America

Wind energy technology played significant role in response to climate change. Increasing academic studies tried to find the relationship between government support and the technology innovation development path. This research filled the literature gap by decomposing national contextual factors with endogenous wind policy design and implementation elements in the theoretical framework. Checking wind energy development in Denmark, Germany, China and India in the past 30 years, this research found influences coming from political context (i.e. governance structure change, governmental policy making capacity), economic context (i.e. national economic development paradigm), and social context (i.e. social legitimacy) that significantly shaped the national wind innovation path. The paper concluded that accessing wind energy policy significantly shaped the national wind innovation path.

Trade flows and knowledge flows: the case of renewable energy generation

E. Verdolini (1); V. Bosetti (2)

(1) FEEM Fondazione Eni Enrico Mattei, CCSD, Milano, Italy; (2) Fondazione Eni Enrico Mattei, Milano, Italy

Fostering sustainable growth while addressing climate change is a concern for energy technology innovation. In particular in countries where multinational firms locate their most dirty production processes. In other countries, other factors such as the wages of R&D workers and the country’s absorptive capacity in green technologies seem to be more important triggers of clean innovation. Since multinational firms are a major channel for transferring technologies to developing countries, our results have implications for the design of policies aiming to promote the global diffusion of clean technologies.

Contextual Factors and Wind Energy Innovation Development — Comparing Germany, Denmark, China and India

Y. Dai (1); J. Nordensvard (2); A. Narain (3)

(1) Tsinghua University, School of Public Policy and Management, Beijing, China; (2) University of Southampton, Southampton, United Kingdom; (3) University of Maryland, Maryland, United States of America

Wind energy technology played significant role in response to climate change. Increasing academic studies tried to find the relationship between government support and the technology innovation development path. This research filled the literature gap by decomposing national contextual factors with endogenous wind policy design and implementation elements in the theoretical framework. Checking wind energy development in Denmark, Germany, China and India in the past 30 years, this research found influences coming from political context (i.e. governance structure change, governmental policy making capacity), economic context (i.e. national economic development paradigm), and social context (i.e. social legitimacy) that significantly shaped the national wind innovation path. The paper concluded that accessing wind energy policy significantly shaped the national wind innovation path.

Trade flows and knowledge flows: the case of renewable energy generation

E. Verdolini (1); V. Bosetti (2)

(1) FEEM Fondazione Eni Enrico Mattei, CCSD, Milano, Italy; (2) Fondazione Eni Enrico Mattei, Milano, Italy

Fostering sustainable growth while addressing climate change is a concern for energy technology innovation. In particular in countries where multinational firms locate their most dirty production processes. In other countries, other factors such as the wages of R&D workers and the country’s absorptive capacity in green technologies seem to be more important triggers of clean innovation. Since multinational firms are a major channel for transferring technologies to developing countries, our results have implications for the design of policies aiming to promote the global diffusion of clean technologies.
Because of climate change mitigation policies or depletion of fossil fuels, fuel prices are expected to rise and an increasing number of households could face difficulties to afford their energy bills, adequately warm their home and achieve their required mobility. If development of fuel poverty measures are necessary to accompany fuel prices rises, their success highly depends on the capacity to identify who are at-risk. Attention has been focused on fuel poverty in the residential sector so far; however traveling by car is another essential energy service for part of the population (Sovacool, 2012). Having too high a fuel spending can induce restriction behaviours and it is particularly problematic when it becomes a barrier to access employment and when it causes social and economic exclusion (Orfeuil, 2004). If an increase in fuel prices will affect more strongly households with the highest motorized mobility needs, here we show that assessing who are those households is not straightforward, and that is for the development of a new multidimensional fuel poverty indicator.

Assessing who the households at-risk are is not a simple task for three reasons. First, motorized mobility needs result from multiple factors depending on the geographic, technical and socioeconomic characteristics of households. For example, living in suburban areas requires traveling longer distances to reach central business districts, or driving an old heavy car requires more energy per kilometre than a brand–new compact car. As a result, the fuel spending can vary a lot among the population. Second, motorized mobility needs are derived from a combination of factors, but these factors are often constrained in the short term, such as the residential location, the efficiency of the vehicle owned or access to public transport. As a result, households do not have the same possibilities to act on their daily lives consumption and they might be forced to restriction behaviour. Third, alternatives to car exist. Public transport, walking and cycling are sustainable substitutes to car use, but these alternatives are not equally accessible to households. Those three reasons highlight the fact that households are unequally affected by increasing fuel prices, and it raises public concerns about their impact on the most vulnerable populations.

The choice of fuel poverty indicators is essential because indicators are the basis on which to quantify the extent of the problem, to identify the affected population and to monitor progress of measures (Moore, 2012). To diagnose fuel poverty in the transport sector, the first idea would be to transpose existing indicators used in the domestic sector to the transport sector. The ratio indicator considers a household is fuel poor if its energy spending exceeds a certain share of its disposable income (Boardman, 1991). A more recent measurement approach, introduced by Hills in the UK, consists in identifying households having both high fuel spending and low income (Hills, 2012). However, there are cases in which such an indicator would fail because they fail to consider the three aspects described above: (1) diverse motorized mobility needs, (2) restriction behaviours, (3) variable capacities to adapt. We develop a new composite indicator that does not solely focus on budgetary aspects but also reflects conditions of mobility.
Community energy generation in the UK: the link between ownership of renewable energy developments and social acceptance

F. Chen (1)
(1) The University of Manchester, Tyndall Centre, Manchester, United Kingdom

Over the last decade, the UK government has increasingly discussed ‘community energy’ as a potential option to contribute towards meeting its renewable energy targets. One of the main compelling reasons is that community energy can bring significant benefits to local communities. The benefits of a community approach are an assumed related reduction in ‘public opposition’ to new renewable energy developments, which has been seen as slowing the rate of deployment and therefore threatening the realisation of related targets.

The link between ownership and social acceptance is an important research question, which has thus far lacked empirical evidence. The aim of this study is to bridge this gap by investigating three wind farm projects with three different types of ownership: fully community-owned, joint venture and fully private-owned communities. The research will employ a wide range of secondary sources and in-depth interviews with key stakeholders of the wind farm projects and the local community residents.

The presentation will elucidate the impact of each ownership model on social acceptance, which will be considered in the context of other issues known to affect social acceptance e.g. the process of consultation with the community, communications and trust between developers and communities, sense of place from the community, contested impacts, processes of monitoring and perceived level of local benefits. The findings of the study will lead to recommendations for various stakeholder groups including local communities, developers and policy makers.

Pacific Community Development Through Biofuel from Marine Biomass

A. De Ramon N’yeurt (1) ; S. Hemstock (2)
(1) The University of the South Pacific, Pacific Center for Environment and Sustainable Development, Suva, Fiji; (2) Secretariat of the Pacific Community, Economic development division, Suva, Fiji

This pilot project based in Fiji with ramifications in Tuvalu and Vanuatu explores the possibilities of developing Pacific island communities a low-cost, sustainable new source of renewable energy (biogas, or biomethane) from pest marine biomass (invasive algal blooms and coral-destroying crown of thorns starfish) to develop the economy of local communities, create employment, reduce food and fossil fuel imports, reduce greenhouse gas emissions, clean up excess nutrients from sewage treatment plant discharges, and clean up beaches fouled by overabundant and invasive seaweeds. The process provides multiple products simultaneously: energy from biogas, a low-cost alternative to chemical fertilizers, plus the recyclable nutrients remaining after anaerobic digestion. The development of low-cost, efficient anaerobic digesters will empower local communities to produce their own renewable energy source while protecting the environment and improving food security. Currently research is underway at the University of the South Pacific in Fiji with two Master-level students working on the topics of biomethane from seaweed and crown-of-thorns starfish, respectively. Pilot community-level trials on the conversion of brown seaweeds into biofuel are underway in Tuvalu.

Local energy and the emergence of the pro-saver

C. Nolden (1) ; N. Fox (2) ; M. Mari (3)
(1) University of Sussex, Centre on innovation and energy demand, Sussex energy group, Brighton, United Kingdom; (2) University of Sussex, Sussex energy group, spru, Brighton, United Kingdom; (3) Centre on Innovation and Energy Demand, Sussex energy group, spru, Brighton, United Kingdom

The publication of the Community Energy Strategy in 2014 indicates increasing recognition of community energy within the UK. Using localised and tacit knowledge, local energy provision allows energy needs to be dealt with at the point of consumption, opening up opportunities for end-users and interest groups to engage in energy provision and act as drivers of local energy developments. This presentation will discuss the potential for community energy provision to address local energy needs including demand reduction and demand side response. The importance of localised energy governance in the UK is highlighted in the Government’s recent D3 report. It specifically refers to the need for ‘pro-saving’ energy, stating ‘pro-saving’ response at a local level, but also takes into account the role that local government can play in their development. A further landmark enabling more distributed approaches is the Government’s Feed-in Tariffs (FiTs), available for renewable energy generation technologies below 5MW. Technological diffusion, combined with an emergence of energy related social innovation and increasing political recognition, is establishing local energy as an alternative to the incumbent energy system. Local energy provides a space for engagement with energy production and consumption at the grassroots level, as well as for local authorities to play a pivotal role in addressing the scale and rapidity of D3 deployment. Often emerging out of community-led renewable energy projects, the initiatives can address issues such as energy prices, fuel poverty and the desire of independence from existing energy utilities.

Based on three case studies, this paper traces the emergence of ‘pro-saving’ and ‘pro-suming’ in a UK context. The first case study, South East London Community Energy (SELCE) examines a community energy group that wishes to generate renewable energy by the community, for the community, and from an array of solar PV panels on public owned buildings such as schools. Their business model is based on income derived from the FiTs and selling electricity at a reduced price. The community group’s second original focus, fuel poverty alleviation, however, had to be initially scaled back due to the difficulty of establishing a viable business model based on FiT income. In the second case study Hyde Farm ClimAction Network set out to find solutions for cold and draughty houses in their neighbourhood, which were restricted by conservation area regulations while people in the area had limited funds to do expensive energy efficiency measures. The community group received support from programmes such as ECHO Action and British Gas Green Streets, which allowed them to install renewable energy installations to some of the houses. However, they proceeded to set up their own ‘Draught Busting Saturdays’ as a way to deal with inefficient houses, address climate change and build community coherence. The Draught Busting Saturday concept proved a popular and an affordable way to improve the energy efficiency, as well as help those who were on low incomes. The third case study provides an example of local authority engagement with fuel poverty alleviation in Southern England. In the summer of 2014, over 150 households were provided with free electricity from solar PV systems installed by their social housing provider, the local authority. The authority paid for the costs of the panels that will eventually be recouped via the FiTs. Any additional revenue generated will be used for energy efficiency work on its social housing stock. The study found that as the households engaged with free energy generation, it also encouraged demand reduction and demand-side responses.

The SELCE case study is an example of ‘pro-suming’ as electricity is being used on the same premises. This approach provides insights into the difficulty of negotiating what may appear to be a straightforward process in light of continuous scepticism towards decentralised energy. The Hyde Farm ClimAction case exemplifies emerging out of a grassroots community approach and disillusionment with established energy providers. The Southern England case provides an example of renewable energy production, consumption and savings, ‘pro-saving’ – emerging out of a local authority initiative. In our discussion we explore how greater engagement
with distributed energy, demand reduction and demand side response may be fostered through a more facilitatory framework combining technological and social innovation at the local energy scale.

P-4413-06

«ENERGY HAVENS»: TOWARDS A SUSTAINABLE ECONOMIC FUTURE. A study based on the example of Iceland

J. Zalpyte (1)
(1) National Institute for Science and Technology, Iceland

There are many concerns on how to enhance environmental policies through participating in the international market with opened borders. For many years already a strong cooperation with countries with lower environmental regulations developed between the United States of America and some western European countries. This development has brought forward a raise of standards in environmental policies across the world but a big gap still prevails in the regulations between developed and developing countries. Some environmental economists claim that trade flows across countries with different environmental regulations may create the “pollution haven” effect and a “race to the bottom” in environmental standards. Globalization and international cross-border cooperation also play a vital role for international tax regimes. Different fiscal policies in one country influence the economic situation in others, even countries located far away. Companies and individual persons use the possibility of increased capital mobility to choose locations where the tax burden is lower. These locations are called “tax havens”. Similar to “pollution havens”, “tax havens” can create a “race to the bottom” in the collective tax base. The similarity of this terminology raises the question what makes a location a tax haven. Since the globalised market is being challenged by an increasing demand for energy and the energy supply is becoming one of the main cost factors in the production process for many industries, the research analysed a new definition of the term “energy havens”. The term “energy havens” describes countries which have a big potential of renewable energy creation that can be provided to “energy-hungry” consumers within the country and the world. This is the aspect which differentiates them from the previously mentioned “pollution havens” because the use of traditional energy sources to offer industries a cheap energy supply suffices the need of the world. The exploitation of renewable energy sources has to be feasible and ecologically desirable in order not to cause harm to nature and «pollute» the environment. The main target groups of this thesis are energy-intensive industries and the academic audience whose interest is the future energy market condition. The research conducted focuses on electricity, with production cost as the main factor.

4414 - Leveraging Multi-layered Climate Science-Policy Social Learning as a Dialogue for Transformative Solutions: Towards A Proposal to “Decade for Accelerating Climate Dialogue for Action"

ORAL PRESENTATIONS

K-4414-01

Learning for a change! The role and challenges of social learning for climate change adaptation

C. Vogel (1)
(1) University of the Witwatersrand, Global Change and Sustainability Institute, Johannesburg, South Africa

Climate change is an additional challenge that arguably we all have to factor into our lives including in local livelihood, local and national government and other decision-making contexts. A commonly heard ‘mantra’ now is “behaviour change” emerging from a sense of urgency that individuals and societies must ‘change’ behaviour so that we can both mitigate and adapt to climate change. Some seem to argue, for example, that we need well-planned ‘dialogue’. But such calls for ‘dialogue’ and ‘change’ cannot be made without understanding the context of the different contexts. Examples of serious attempts to make inputs of local and national government and other decision-making contexts include the implementation of science-based policies for low-carbon societies. LCS gained currency when it was realized that, on the one hand drastic GHG emission cuts necessitating major changes in energy systems and socio-economic structures are essential to prevent dangerous climate change, and on the other hand every country’s domestic developmental goals must not be compromised. Attempts to achieve convergence among the multiple goals of global climate change mitigation, national economic development, poverty elimination, sustainable development and environmental protection, have led to the importance of LCS and related paradigms.

The role of Asia is becoming more and more important, considering the rapid economic growth expected in the coming decades and projected doubling of greenhouse gas emissions from 2005 to 2050 if efforts are not made toward achieving LCS. The reduction of emissions in Asia is imperative for transition by 2050 to a worldwide LCS that has halved GHG emissions from 2005 level. Transition to low carbon emissions and low-resource consumption societies, while simultaneously improving the economic standards of living is vital for sustainable development. Asia has many opportunities to realize an LCS by leapfrogging.

We have been engaged in the development of Asia-Pacific Integrated Model (AIM), which assesses policy options for stabilizing the global climate, particularly in the Asian-Pacific region, with the objectives of reducing greenhouse gas emissions and avoiding the impacts of climate change. Modeling is essential to understand the future pathways and support policy making processes for transformation to LCS.

Sustained efforts have been made to develop AIM model and transfer it to various Asian countries for developing LCS scenarios in each country over the past two decades. These include science-policy dialogues to implement LCS scenarios. One of important networking activities is Low Carbon Asia Research Network (LoCARNet) which was established in 2012 to formulate and better enable the implementation of science-based policies for low-carbon development in the region. This is expected to become an autonomous researchers’ network based on south–south

K-4414-02

Realizing low-carbon Asia based on science-policy interaction through Low Carbon Asia Research Network (LoCARNet)

M. Kainuma (1) ; T. Masui (2)
(1) Institute for Global Environmental Strategies / National Institute for Environmental Studies, Senior research advisor / fellow, Tsukuba, Japan; (2) National Institute for Environmental Studies, Center for Social and Environmental

Systems Research, Tsukuba, Ibaraki, Japan

Realizing Low Carbon Society (LCS) has become a common understanding of the global community of policymakers and citizens engaged with the concerns of climate change and sustainable development. LCS gained currency when it was realized that, on the one hand drastic GHG emission cuts necessitating major changes in energy systems and socio-economic structures are essential to prevent dangerous climate change, and on the other hand every country’s developmental goals must not be compromised. Attempts to achieve convergence among the multiple goals of global climate change mitigation, national economic development, poverty elimination, sustainable development and environmental protection, have led to the importance of LCS and related paradigms.

The role of Asia is becoming more and more important, considering the rapid economic growth expected in the coming decades and projected doubling of greenhouse gas emissions from 2005 to 2050 if efforts are not made toward achieving LCS. The reduction of emissions in Asia is imperative for transition by 2050 to a worldwide LCS that has halved GHG emissions from 2005 level. Transition to low carbon emissions and low-resource consumption societies, while simultaneously improving the economic standards of living is vital for sustainable development. Asia has many opportunities to realize an LCS by leapfrogging.

We have been engaged in the development of Asia-Pacific Integrated Model (AIM), which assesses policy options for stabilizing the global climate, particularly in the Asian-Pacific region, with the objectives of reducing greenhouse gas emissions and avoiding the impacts of climate change. Modeling is essential to understand the future pathways and support policy making processes for transformation to LCS.

Sustained efforts have been made to develop AIM model and transfer it to various Asian countries for developing LCS scenarios in each country over the past two decades. These include science-policy dialogues to implement LCS scenarios. One of important networking activities is Low Carbon Asia Research Network (LoCARNet) which was established in 2012 to formulate and better enable the implementation of science-based policies for low-carbon development in the region. This is expected to become an autonomous researchers’ network based on south–south

723

7-10 JULY 2015 / PARIS, FRANCE

INTERNATIONAL SCIENTIFIC CONFERENCE

ABSTRACT BOOK
Several international research platforms of researchers have already made tremendous contribution to comparative analysis of socio-economic characteristics among different countries and stakeholders. They have developed integrated assessment models for setting de-carbonization future targets and optimal roadmaps, and shared the implementation process in designing collective solutions for national low carbon policies, infrastructure plans, eco–model city designs and industrial transformation processes. During all such collaborative research network activities, analytical methods, simulation models and evaluation indicators have been shared, investigated and refined.

The presentation will provide an overview of various analytical methods and tools used as a common scientific framework in Asia. This will include the integrated future scenario simulation system for a de-carbonization society and data-driven roadmaps to achieve the 2 degree target. The presentation will also provide implementation examples from Asia that showcase transformative actions towards de-carbonization.

Implementing the long term transition towards Low Carbon Societies

S. Lechtenböhmer (1)

(1) Wuppertal Institut für Klima Umwelt Energie, Research Group Future Energy and Mobility Structures, Wuppertal, Germany

The work of IPCC and international governments has clearly established the global problem of climate change and identified possible solutions. It makes very clear that achieving a global climate compatible Low Carbon Society entails a «great transition» will change economies and technology and involve all societal groups to work together on coherent long term oriented strategies. This means that societies have to jointly develop long term visions that are able to guide short term oriented interests and activities. Such a venture needs engagement between all societal groups on all levels from local to global. The keynote will highlight the relevance as well as the potentials of collaboration between science and society by highlighting two relevant examples on Global as well as regional levels and by this making clear, what is needed for a global LCS transition.

In 2008 the G8 environment ministers decided to contribute to the global challenge of co-evolution of Low Carbon transition strategies between policy science and society. Based on a proposal by Japan they decided to create the Low Carbon Society Research Network. A network of science and governments of the G8 together with researchers from developing countries with a purpose to link together national discussions and strategies on LCS and to convey core LCS issues to international policy makers. The network has so far identified a clear international set of issues and was able to convey them into policymakers discussions.

Global approaches, however, need similar ones on other levels. One very intensive example is the climate law and strategy of the German state of North–Rhine Westphalia. This region hosts over 50% of German coal fired power generation and energy intensive industries, but is determined to achieve climate commitments in order to make progress towards the goals and to create a cross–societal movement a broad and long term oriented stakeholder process was implemented that already resulted in a policy program supported by all stakeholder groups.

A Transformative knowledge network of global youth for combating climate change: an intercultural perspective

J. Li (1) ; H. Dayan, (2)

(1) Curtin University of Technology, Perth, Australia; (2) EHESS, Centre edgar–morin, Paris, France

Understanding the societal, economic and environmental issues raised by the climate change at both global and local level calls for the synergy of disciplinary knowledge and cooperation between stakeholders of international community. It is widely recognized that today’s youth will be the first group affected by the consequences of climate change on the socio–economic–environmental biosphere towards a sustainable future. They could be crucial in the creation and participatory intelligence that would contribute to concrete proposals for curtailing the accelerated global warming. This requires creating opportunities for exchange and exchange between global youth citizens from diverse sociocultural backgrounds and interaction with researchers on the state of the climate situation and scientific knowledge on the one hand, and enabling them to discuss possible solutions on the other hand.

The project seeks to leverage interdisciplinary knowledge and intercultural experience sharing between young people from various cultural, scientific, and social backgrounds in order to facilitate open exchange and dialogue between diverse youth groups as well as with their interactions with global communities. The project harnessing Information and Communications Technology (ICT) and social media. Two “crowdsourcing” tools, an online platform and offline focus groups, are dedicated to gaining and sharing relevant research data as well as with their interactions with global communities. The project harnessing Information and Communications Technology (ICT) and social media. Two “crowdsourcing” tools, an online platform and offline focus groups, are dedicated to gaining and sharing relevant research data as well as knowledge on the one hand, and enabling them to discuss possible solutions on the other hand.

The permanent online platform and scheduled offline meetings between young people from different parts of the world will commit to securing sustainable economic growth and to strengthen their voice in the world of global youth and local communities as well as taking local actions to address climate change. This platform will be constantly enriched and improved through young people’s innovative thoughts and ideas within a new and inclusive economic, social and cultural context. It will also lead to the restitution of data on scientific knowledge and analysis of the perception and the proposals of the young students on climate change from an interdisciplinary research perspective. It must be emphasized that the interdisciplinary treatment of a scientific topic is concerned not only with the technological &socioeconomic aspects but also to those related to age, gender and culture.

Multi–dimensional analysis of the first results which will emerge at a meeting gathering all the actors of the project in Toulouse in May 2015 will be the aim of this scientific communication. Results are expected to mark a significant step in enhancing knowledge, training and implementation in addressing scientific questions in relation to sustainability. The success calls on global community to bring together knowledge of environmental scientists and social scientists as well as associating engineers and people pays particular attention to intercultural dialogue/understanding, from which a collective intelligence of solutions especially among young people could emerge. The project expects to deliver a «Global Youth Climate Pact » at the Paris COP-21 in Dec 2015 as a result of a series of collaborative work between young students with the support of various international institutions including academia and NGOs as well as regional governments.
Agriculture and Food Security (CCAFES), ILRI, Policies and institutions for climate resilient food systems, Nairobi, Kenya; (2) International Development Research Centre (IDRC), Collaborative adaptation research initiative in africa and asia (Caria), Ottawa, Canada; (3) Consultant, Muenich, Germany; (4) International Livestock Research Institute (ILRI), Addis Abeba, Ethiopia

Climate change adds considerable uncertainties and complexities to what are already multidimensional development challenges. It is increasingly likely that we are already locked into a two-degree temperature rise, whatever happens to global greenhouse gas emissions even in the unlikely event there is ample evidence that the resources needed to deal with the adaptation challenges exceed the resources currently mobilized for it. However, it is not just about resources: the approaches that many of our institutions are taking are failing to address the level of complexity and the cross-scalar nature of the challenges that are triggered by climate change in the context of development. Business as usual is, simply, not fit for purpose. This is becoming increasingly recognised at different levels, from partners on the ground right up to international funding agencies.

In response, a lot of useful practical and theoretical work is being undertaken on the value of learning and reflective practice as a way to bring together different knowledges and to address the multiple dimensions of complex problems, and to take learning beyond the local into much wider networks of practice. Social learning and similar learning-based approaches are building a compelling body of evidence on their potential at multiple scales, but we know that the scale of the climate change challenge demands more than isolated community scale actions. Supported by recent scholarship in this area, we argue that the principles emerging from local-level learning approaches are equally applicable at higher scales, and have the potential to achieve an important shift in thinking across levels. Such work is providing increasing clarity as to what counts as research, collaboration, and disposition, to problem solving are needed to address the levels of complexity and uncertainty we are facing under climate change in a development context.

This need for doing things differently, however, is not yet reflected in most organisations addressing the climate change challenge. This is in part because of the response from organisations funding research for development that place much of the onus on taking transformative change to scale on actors and initiatives working at the last mile of planning and practice. While work at this level is critically important, it is not sufficient, and this emphasis sometimes leads to a focus on “silver bullet” technological fixes rather than broader systemic changes.

We need to see the emergence of joined-up learning-oriented models of practice, at all levels. By changing the way our own institutions think about fostering solutions to what we call the “climate change” challenge, we can also begin to scale the longer-term impact on how knowledge and action link up in this field. However, this requires social learning or related approaches to instil institutional and organisational change. We currently have very few examples of success at these levels to guide us.

Thus, the Climate Change and Social Learning Initiative has embarked on a process to contribute to a solid evidence base concerning the costs and benefits of social learning in different contexts. This is one of a number of iterative, learning-based approaches that offer a potential avenue for understanding and acting on. Jointly with development organisations we are testing a common monitoring and evaluation framework to systematically collect evidence, analyse results and share learning on when and how research initiatives may benefit from social learning-oriented approaches.

The evidence we are building should show tangible proof of the added value of these approaches towards achieving development outcomes. To take things to the required scale, the stakes need to be raised: we need nothing less than a major re-think as to how research for development is used and how it can tackle one of the most complex challenges of our time. To this end, this contribution will conclude with a set of “pathways to transformation” with which we challenge institutions funding and supporting climate change research for development to pursue.

---

O-4414-03

Systemic and social learning approaches for climate change adaptation: Experiences from transboundary work in Southern Africa

S. Pollard (1) ; H. Biggs (1) ; D. Du-Toit (1) ; K. Taryn (1) ; C. Vogel (2)

(1) Association for Water and Rural Development, Non governmental organisation, Hoedspruit, Limpopo, South Africa; (2) University of the Witwatersrand, Global Change and Sustainability Institute, Johannesburg, South Africa

For climate change adaptation to be successful attention needs to be given to how people might learn to adapt. Theories of social learning enable an exploration of adaptive capacity and how people are learning to deal with climate change amidst a range of other challenges, whilst systemic approaches enable thinking about complex and often unpredictable situations. In South Africa the RESILIM–Olifants project is a multi-year learning approach that is enabling actors at various levels, from households through to catchment management agencies and transboundary organisations to build resilience to climate change in creative ways. Lying at the core of the systemic, social learning process is a collaborative scoping of the context and of the risks and challenges which, when viewed through a systemic lens, helps stakeholders understand change within complex and dynamic environments. Some of the lessons and challenges learnt in this “creative transdisciplinary endeavor”, which is being led by the Association for Water and Rural Development, will be outlined, critiqued and shared.

---

O-4414-04

Title not communicated

S. Nishioka (1)

(1) Institute for Global Environmental Strategies (IGES), Japan

Abstract not communicated

O-4414-05

China’s Emission Pathway towards global 2 degree target: Policies and Scientific Support

K. Jiang (1)

(1) Energy Research Institute (ERI), Beijing, China

Low carbon development in China is on the purpose for both national sustainable development and global climate change action. For the global climate change target “to hold the increase in global average temperature below 2 °C above preindustrial levels”, China need to peak CO2 emission at latest at 2025, and falling into deep cut on CO2 emission, based on the IPCC report(IPCC AR5, 2014). Previous studies on emission scenario shows that it is possible for China to peak CO2 emission by 2030 if strong policies are adopted, and with a relatively high cost. Peaking CO2 emission before 2025 is a very big challenge for China. Modeling study by IPAC on the 2 degree target said it is also still possible for China to peak CO2 emission before 2025, but several pre-condition are needed, including optimizing economy development, further energy efficiency improvement, enhanced renewable energy and nuclear development, CCS etc.

In recent years, China’s policy making process moved much faster than before to tackle climate change issues. Started from 12th Five Year Plan, CO2 intensity target over GDP growth was set up for 2015. And domestic actions including emission trading, low carbon provinces and cities pilot program. The most remarkable achievement is the China–US Joint Announcement on Climate Change, it mentioned about the desire for global 2 degree target, and China set up year to peak CO2 emission, and express that to continue to work to increase ambition over time. Besides this, China’s policies on low carbon energy utilization including renewable energy and nuclear is moving very fast. By 2015, China’s newly installed capacity of wind and solar power generation accounts for more than 1/3 of globale total. If put hydro and nuclear power together, China accounts for more than 40% to total newly installed capacity of the world.
In order to support the policy making process, China engaged in a participatory process, coordinated by the Climate Change Policy Expert Panel for official advice. They rely on large amount of research work to make suggestion. Beside this, there are many workshops and internal meetings to discuss the possible implementation of policies on mitigation of GHG. The policy making on climate change depends much on research support. Our researches were adopted in the national peaking year setting, and ETS design. And now we are working on the carbon, which is regarded as another significant policy in China.

China also made efforts to promote south-south collaboration. China already led several dialogue on south-south for capacity building. This will be a direction for China to join international collaboration to help developing countries to respond to climate change.

O-4414-06

Science-policy-stakeholder dialogues about Low Carbon Society: Lessons from the Brazilian Case

E. La Rovere (1)

(1) Instituto de Pós-Graduação e Pesquisa de Engenharia – COPPE, Centro de Estudos Integrados sobre MeioAmbiente e Mudanças Climáticas – CentroClima, Rio de Janeiro, Brazil

Science-policy-stakeholder dialogues about Low Carbon Society: Lessons from the Brazilian Case

Achieving a Low Carbon Society entails a «great transition» of economies and technology requiring the involvement and action of different societal groups. This keynote will draw the lessons from a science-policy-stakeholder dialogue about mitigation GHG emission scenarios for Brazil.

A participatory process to discuss the economic and social implications of five mitigation scenarios for Brazil up to 2030 was held from April 2014 to March 2015, coordinated by the Brazilian Forum on Climate Change. It involved a Scenario Building Team (SBT) of 70 members from the government, business sector, non-governmental organizations (from the environmental field and trade unions) and the scientific community. A team headed by the Brazilian member of LCS-RNet (CentroClima/COPPE/UFRJ) has provided scientific support to the process. Upon draft proposals suggested by TMT, SBT selected quantitative and qualitative indicators and performance bases based upon economic and technological assumptions. TMT has translated these inputs in quantitative projections of key variables depicting economic and GHG emissions, calculated through mathematical models representing the Brazilian economy and technical systems: IMACLIM-BR (CGE macroeconomic model especially designed for long-term GHG emission scenarios building) and sectorial models for energy, land use and forestry, IPPU and waste.

The general objective was to design exploratory long-term scenarios, and not forecasts or a normative scenario. The goal was not to supply the most probable nor the most desirable scenario. A comparative analysis between long-term scenarios, and not forecasts or a normative scenario: The general objective was to design exploratory long-term scenarios, and not forecasts or a normative scenario.

4414 - POSTER PRESENTATIONS

P-4414-01

Management, hazardous waste treatment and environmental impact

K. Allia (1)

(1) USSTHB, Chemical Engineering, Algiers, Algeria

Improvement of standard living led and will continue to generate a rather big environmental risk, given the significant amount of multiple wastes they produce and depending on the case may be landfilled or finally recycled. According to their nature and production source, they can be medical, agricultural, municipal, industrial etc. and the protection of human health and ecosystems is much more difficult than years ago. Environmental issues are more diffuse rather than located, subtle than obvious, and involve multiple environmental media (air, water, ground, sediments and biota). This keynote will draw the lessons from a science-policy-stakeholder dialogue about mitigation GHG emission scenarios for Brazil.

Lessons from the Brazilian Case

Achieving a Low Carbon Society entails a «great transition» of economies and technology requiring the involvement and action of different societal groups. This keynote will draw the lessons from a science-policy-stakeholder dialogue about mitigation GHG emission scenarios for Brazil.

A participatory process to discuss the economic and social implications of five mitigation scenarios for Brazil up to 2030 was held from April 2014 to March 2015, coordinated by the Brazilian Forum on Climate Change. It involved a Scenario Building Team (SBT) of 70 members from the government, business sector, non-governmental organizations (from the environmental field and trade unions) and the scientific community. A team headed by the Brazilian member of LCS-RNet (CentroClima/COPPE/UFRJ) has provided scientific support to the process. Upon draft proposals suggested by TMT, SBT selected quantitative and qualitative indicators and performance bases based upon economic and technological assumptions. TMT has translated these inputs in quantitative projections of key variables depicting economic and GHG emissions, calculated through mathematical models representing the Brazilian economy and technical systems: IMACLIM-BR (CGE macroeconomic model especially designed for long-term GHG emission scenarios building) and sectorial models for energy, land use and forestry, IPPU and waste.

The general objective was to design exploratory long-term scenarios, and not forecasts or a normative scenario. The goal was not to supply the most probable nor the most desirable scenario. A comparative analysis between long-term scenarios, and not forecasts or a normative scenario: The general objective was to design exploratory long-term scenarios, and not forecasts or a normative scenario.

The combustion gases are composed primarily of carbon dioxide and water, and small amounts of carbon monoxide, nitrogen oxides, and low concentrations of organic and inorganic compounds like many combustion processes, incineration also produces by-products such as soot particles and other contaminants released in exhaust gases, and leave a residue (bottom ash) which can contain hazardous waste that must be emptied from incinerator chambers and properly disposed. Expired or unused pharmaceuticals are now incinerated, in facilities that could meet the highest environmental standards, including treatment of smoke and where releases requiring to be a
Mind Games: Our (Un)conscious Struggle with Climate Change

H. Berry (1)

(1) The Australian National University, Climate Change Institute, Canberra, ACT, Australia

Background/purpose: Some media and academics have proposed that informing the public about the climate change is a key environmental issue with major concerns with respect to the rise in global temperature and concomitant direct and indirect implications. Recently, there has been an international momentum to stay within the agreed target of 2°C increase above the pre-industrial global mean temperature, by 2050 (Erika von et al, 2013). Increasing greenhouse gases from anthropogenic activities, particularly, has been established as the major force behind climate change and the warming of the Earth.

Discussion/conclusion: Mental health problems are the most pressing than climate change mitigation. In South Africa, cities currently reflect severe inequality in terms of access to opportunities and differing levels of mobility amongst citizens, being two major contributing factors. Like other South African cities, Cape Town’s urban form was significantly influenced by apartheid policies, which sought to segregate the population, based on race and placed low-income communities, in particular, far from the urban core. This was combined with a strong private car orientation from the 1960s onwards underpinned by substantial investment in roads and highways, which led to low densities and long commuting distances. Thus, mobility in South African cities is associated with high emissions per passenger kilometre travelled, and entrenches the levels of inequality across income groups in cities.

The bus rapid transit (BRT) concept was presented to the South African government at a time when traffic congestion was worsening, along with the rise in private vehicle ownership associated with a growing middle class, and was forecast to be the game-changer. The realisation that expanding the road network would not alleviate the congestion; instead a sufficiently attractive alternative was required to entice private vehicle users away from their cars. The existing buses and trains were unlikely to induce this shift, but BRT, it was thought, could be such an alternative.

This case study investigates the implementation process of the MyCiTi BRT in Cape Town, and identifies major factors that were influential in bringing about implementation, despite significant obstacles the project had to overcome. Some of these factors include: the role of support from national government, the presence of leadership within government and with stakeholders (especially the minibus taxi industry), the role of the 2010 FIFA World Cup in driving progress at speed, a competent and dedicated project team, and the influence of the industry transition of the minibus taxi industry. Most influential was the unique combination of factors and timing that drove implementation.

It is intended that the findings from this case study will provide insights into the likely outcomes of transformative actions in difficult circumstances, that achieve multiple objectives, amidst opposition and competing policy goals.
Based on experiments in the branch of psychology called 'Terror Management Theory'. This body of evidence proves that humans associate nature and the body with death, and thus we fear nature; and that symbols and artefacts of power such as money, economic growth, consumer products, technology, organizations and nations give us a deep sense of power and even immortality (Dickinson, 2009; Fritsche & Hafner, 2012).

Our attachment to these human artefacts and systems is stronger than their actual usefulness warrants, because at a deep psychological level they allow us to deny our mortality, to ignore the natural world that sustains us, and to imagine that our existence is independent of the systems that may appear to defy physical reality (Arndt & Vess, 2008; Kiehl, 2012). The perceived authority of these financial and cultural systems thus encourages citizens to indulge in psychological ‘fantasies of omnipotence’ in particular the notion that the economy contains ecology, and the idea that perpetual economic growth is a legitimate goal for countries and for globalized society (Daly, 2014; Ellman & Reppen, 1997; Lohane, 1997; Morante, 2010).

This contribution posits that the power of these salient fantasies of omnipotence is waning in favour of the New Story. As mentioned, the New Story is an evidence-based understanding of the place of humans within the living and non-living flows of the Earth and the cosmos, including the built city of deep time (Murdoch, 2009; Babloyantz, 1972; Rifkin & Howard, 1980). This paper proposes that the New Story is more than just a collection of scientific facts and trends – in psychological terms, the New Story has transformative and revelatory potential, because it reverses the normal cultural veneration of fantasies of omnipotence. The revelation of the New Story includes an appreciation that we are not powerless and do not need to fear nature (Searles, 1972).

In a nutshell, the New Story is an encounter with the joy of physical being, and it brings with it an appreciation of the sensitive and contingent nature of human existence (Latour, 1993, 2012). This contribution will discuss the transformative power and practical implications of the New Story, with particular focus on how the New Story may help to create the necessary foundation of a sustainable financial system (Benes & Kumhof, 2012; Fiscus, 2013; Georgescu-Roegen, 1971).

The call for transformation has been taken up in international climate policy. The Green Climate Fund (GCF) has been given a mandate to facilitate a “paradigm shift” and other international funding mechanisms such as the British–German NAMA Facility also demand that activities associated with the transformation of the energy supply system, including the long-term phase-out of unabated fossil fuel conversion technologies and their substitution by low-CHG alternatives.

A New Market-based Mechanism (NMM) was already defined under the UNFCCC in 2011 in Durban. While discussions have only recently begun, it is guided by a set of criteria that include inter alia that the NMM should stimulate mitigation across broad segments of the economy, safe-guard environmental integrity, and ensure a net decrease of global greenhouse gas emissions. The EU has called for the NMM to facilitate
transition towards low carbon economy and attract further international investment".

On this basis, our contribution analyses what the transformative potential of the NMM is in general and how it should be designed in order to maximize this potential. As basis for the discussion, the paper first synthesizes how transformation has been defined in scientific literature and existing climate policy initiatives. Based on this synthesis the research team identifies key criteria for how to define transformational impact. Second, the paper examines the transformative potential of market-based instruments on the basis of the EU ETS, so far the largest market-based mitigation instrument in existence. Third, the paper takes stock of the current discussion on the design of the NMM and applies some of the insights from the case study analysis to the case of the NMM. We conclude by translating these insights into policy recommendations for the further consideration of the NMM under the UNFCCC.

P-4414-07

Science Policy dialogue to formulate Low carbon society blueprint of cities in developing countries – The case of Iskandar Malaysia

CS. Ho (1)

(1) University of Technology Malaysia, Built Environment, Johor bahru, Johor, Malaysia

Our common future under climate change needs knowledge sharing platform to promote low carbon societies development, climate resilient planning and engaging local government officials on climate mitigation measures of managing urban development infrastructure to cater for the rapid urbanisation and industrialisation. With holistic climate resilient planning, low carbon society blueprint measures could both achieve of the government objectives on strengthening economic competitiveness and improve quality of life, and its aspiration for promoting green economic growth and greater sustainability.

This presentation outlines the experiences gained and lessons learnt through the multidisciplinary ‘Science-to-Policy’ approach to drawing up and mainstreaming the Low Carbon Society Blueprint for Iskandar Malaysia 2025 (LCSBP-IM2025) for implementation in Iskandar Malaysia (IM), a rapidly developing urban region in the southernmost tip of Peninsular Malaysia. This is also in line with the commitment of the Malaysian government to voluntarily reduction pledge in COP15 of carbon emission intensity of GDP by 40% by 2020 based on the 2005 level.

The LCSBP-IM2025 is the outcome of an internationally funded joint research under the SATREPS program that brings together Universiti Teknologi Malaysia (UTM), Kyoto University, Japan’s National Institute for Environmental Studies (NIES), Okayama University and the Iskandar Regional Development Authority (IRDA) in a unique ‘academia–policymaker’ partnership towards crafting a LCS pathway to guide and sustainably manage the projected rapid development in IM in the next 10 years. A methodology has been developed to formulate IM’s future LCS scenarios; propose 12 LCS Actions to achieve the LCS BP-IM2025; and take stock of the current discussion on the design of the NMM under the UNFCCC. We conclude by translating these insights into policy recommendations for the further consideration of the NMM under the UNFCCC.

P-4414-08

A study on the Korean model for greenhouse gas mitigation of livestock industries

HU. Kim (1)

(1) National Academy of Science, Korea, Natural Science, Div. 5(Agriculture), Seoul, Republic of Korea

CGIRC of Korea reported Korean agriculture emitted 22 million tons of CO2 eq., which is 0.6% of total emission, 688.7 million ton CO2 eq. in 2012. Korean livestock industries are characterized by the intensified production system and the heavy dependency on the grain imports. Recently Korean livestock industries have been suffering from many problems like feed price increase, animal pandemics, increasing meat imports, and harder control on the environmental problems including GHG emission. In 2010, averaged Korean consumed about 110 grams of animal meat daily (excluding dairy products, fish, and soybeans), and they love to eat grilled–beef ribs and bacon high in fat. The population of the obese people and the death toll from the circulatory problems have been raising steadily in recent years, which raised the national medical expenses and the import budget of the meat and feed grains. They should tackle on many GHG-related problems of Korean livestock industries collectively, including the obesity, the residue utilization, the clean energy supply, the animal disease control, and the grain import, all of which are inter-related and caused by the human activities.

For GHG mitigation of livestock industries, they should start from the nutrition education programs, which could persuade the people to cut down the fatty meat meal to a recommended level to control the urgent obesity problems, and they have to renew the animal production system urgently to a renewable one, which they could manage the feed supply, and control the animal pandemics and the pollution problems. Korean meat grading system giving the top grade to the heavily marbled meat must be amended to a healthier meat grading system. The import of given meat must be possibly reduced. The fattening practices of cattle before marketing and the high–grain feeding must be abandoned. Recently probiotic lactic acid bacteria have shown to decrease the intestinal and the rumen gas production as well as the noxious smell of the man and animal feces. More researches are needed for the ruminant yogurt which could decrease GHG emission and enhance the feed efficiencies, which will provide a natural tool to solve the GHG problems of animal industries. The organic residues from livestock operations, food industries, and residences must be collected and digested anaerobically for the production of clean biogas as well as organic fertilizer, which could help the GHG problems, the pollution problems, and the clean energy demands. This concepts for GHG mitigation is hoped to help the nation to decrease the GHG emission from livestock industries and solve some other related problems like the grain import budget and the national medical expenses. When we consider our history of meat-eating, the dependency on grain import, the obesity problems, and many difficulties to build up the Korean livestock industry, this model for GHG mitigation could be a probable one especially in Korea, which might serve the nation as well as the world then. The methane fermentation is ancient, prevalent, and natural, but I believe we could manage to control GHG problems from livestock operations for our common future.

P-4414-09

Shifting the Epistemology of Gender and Climate Change

C. Jost (1) ; N. Ferdous, (1) ; A. Otzelberger (2) ; P. Kristjanson (3)

(1) World Agroforestry Centre (ICRAF), Climate Change Science Domain, Nairobi, Kenya; (2) Independent Consultant, Germany; (3) Swedish University of Agricultural Sciences, Department of Environment and Natural Resources Management, Uppsala, Sweden

One of today’s most pressing challenges is the need for transformational societal change with regard to the mitigation of global climate change. This will involve substantial structural changes or transformations in individual and collective mindsets, or epistemologies. This paper explores the concept of the ‘lifeworld’ as a mechanism for understanding epistemological change. The paper will consider epistemological change through a review of the literature on gender, gender identities, and ‘disciplinary gaps’ that are bound to arise. Most importantly, the methodology can also be disseminated to other developing countries where implementation of low carbon society policies will eventually counteract mitigating global climate change through real cuts in GHG emissions while still achieving a desired level of economic growth.

ABSTRACT BOOK
To move the discourse related to gender and climate change beyond the conceptualization of women as a homogenously vulnerable group, we engaged in a social learning experiment that led to the creation of the Gender and Inclusion Toolbox jointly produced by CCAsF, ICRAF and CARE. By documenting the processes used, we were able to observe how changing research power and norms, and shifting incentives through partnerships, were possible despite the complexity of actors and interests involved. We achieved triple-loop-learning, as feedback from scientists and field-testing looped back to re-evaluating and changing modules, methods and practices. Joint learning can happen in planned or unplanned ways, and its extent and success is shifted to involve all planned partners, while opportunies to work with others arose. In this sense, the triple-loop-learning that lead to the decision to orient the Toolbox as a development practitioner’s resource rather than a purely research resource also led to changes in our partnership needs. As we moved away from expert knowledge and technical language, the assumption that communities have the capacity to shape discourse and also their own development visions took better hold. In this way, the role and sensitization of development practitioners in doing participatory research and social differentiation analysis became of utmost importance in promoting social learning across diverse groups. Shifting the research process to be more participatory and investing in downstream actors can facilitate sensitization to improve gender and social differentiation analysis. If development practitioners are not expected to share in responsibility over research outputs, and in many cases have no idea what research objectives various approaches in a study are, conducting gender-sensitive research in particular becomes highly problematic.

P-4414-10

Integrated Assessment Modelling to Enhance Climate Policy Design in Thailand

B. Limmeechokhrai (1)

(1) THAMMASAT University, Sirindhorn International Institute of Technology, Pathumthani, Thailand

In the climate change framework, there is a gap between modeling analyses and policy development. The adoption of national climate policy from modeling analyses depends on several factors. Through policy dialogue on pathways to low emission development, Thailand succeeded in reflecting the modeling analysis into actual policy development in its Nationally Appropriate Mitigation Action (NAMA) in 2014. Thailand’s scenario studies on NAMA and NAMA roadmap development in the country have been very successful. In COP20, Thailand communicated its mitigation pledge for greenhouse gases (GHG) reduction potential in 2020 to UNFCCC. Thailand experienced in Integrated assessment modelling (IAM) in the climate policy design. In addition, presenting Thailand’s also emphasizing its sharing of its intended Nationally Determined Contribution (NDC) for its GHG reduction potential in 2030. It is clear that the IAM is an effective catalytic role to enhance the policy dialogue. This lesson learnt can be applicable to other regions as a “good practice” of climate policy design; though adaptation is needed to fit local conditions.

P-4414-11

Cross-Cultural Dialogue for Sustainable Development ethics

JE. Marcos (1)

(1) RSE&Interculturalité – Elan Interculturel, Training and Cross-Cultural Communication, Paris, France

After investigating Climate Change from a sociological and a cross-cultural perspective, I realized that the problem and the subsequent ecological crisis in which we find ourselves today is, above all, an ethical crisis. My work and research has no higher aspiration than to recapitulate some of the prima facie thoughts on sustainable development ethics to better address the cross-cultural Climate Change Dialogue and negotiations. No doubt the subject is vast, complex, and almost incomprehensible. However, I assume the risk of a disorderly exhibition of ideas because I believe that it better reflects the current state of ethical thinking towards climate change crisis.

The motley collection of ideas presented may seem broad, heterogeneous and little detailed; it is just a hint that obviously is neither finished nor exhaustive. Its purpose is to delineate some of the regulatory requirements, cognitive preconditions and political preconceptions that may be needed for an ecological reorientation of activities and social practices. I am convinced that there is much to think and a lot to work with: it is essential not to fear ridicule and to make continuous proposals, like bottles thrown into the sea.

Along my presentation, the aim of my research and work will not be to make a specialized proposal. On the contrary, after establishing the technical state of the question on climate change, I will devote a few paragraphs to the explanation of a fundamental principle for understanding why we reached this ecological crisis. Thereupon, I will try to demonstrate a central point: the importance of rethinking the cross-cultural notion of planning. Finally, and after having presented some guidelines for the questions that guide present time, I will summarize the central problems and some of the main contributions that ethics can provide on the sustainable development question.

The problem that I will first address in my presentation is simple: to what extent climate change and sustainable development is a social challenge that requires an ethical approach? The fact is that international climate change negotiations are complex, especially because we are talking about different cultures sharing the same problems, but not necessarily sharing the same solutions. And, without a common point of reference, it’s been a long time since we are running forward, en "fuite en avant".

To expect that a new cross-cultural conscientiousness is led by the current state of political representation seems nonsense. The present dynamics of representative democracy is limited to meet demands of orthodox economics and a false conception of prosperity --linked most of the time to the myth of unlimited growth and a conception of men as a free consumer--. But prosperity cannot be reached just by playing the growth game. A new ethic of sustainable development must favour a humanistic and cross-cultural approach on progress that cannot be reduced to the accumulation of material goods. The present dynamics of representative democracy is limited to meet demands of orthodox economics and a false conception of prosperity --linked most of the time to the myth of unlimited growth and a conception of men as a free consumer--. But prosperity cannot be reached just by playing the growth game. A new ethic of sustainable development must favour a humanistic and cross-cultural approach on progress that cannot be reduced to the accumulation of material goods. The present dynamics of representative democracy is limited to meet demands of orthodox economics and a false conception of prosperity --linked most of the time to the myth of unlimited growth and a conception of men as a free consumer--. But prosperity cannot be reached just by playing the growth game. A new ethic of sustainable development must favour a humanistic and cross-cultural approach on progress that cannot be reduced to the accumulation of material goods. The present dynamics of representative democracy is limited to meet demands of orthodox economics and a false conception of prosperity --linked most of the time to the myth of unlimited growth and a conception of men as a free consumer--. But prosperity cannot be reached just by playing the growth game. A new ethic of sustainable development must favour a humanistic and cross-cultural approach on progress that cannot be reduced to the accumulation of material goods. The present dynamics of representative democracy is limited to meet demands of orthodox economics and a false conception of prosperity --linked most of the time to the myth of unlimited growth and a conception of men as a free consumer--. But prosperity cannot be reached just by playing the growth game. A new ethic of sustainable development must favour a humanistic and cross-cultural approach on progress that cannot be reduced to the accumulation of material goods. The present dynamics of representative democracy is limited to meet demands of orthodox economics and a false conception of prosperity --linked most of the time to the myth of unlimited growth and a conception of men as a free consumer--. But prosperity cannot be reached just by playing the growth game. A new ethic of sustainable development must favour a humanistic and cross-cultural approach on progress that cannot be reduced to the accumulation of material goods. The present dynamics of representative democracy is limited to meet demands of orthodox economics and a false conception of prosperity --linked most of the time to the myth of unlimited growth and a conception of men as a free consumer--. But prosperity cannot be reached just by playing the growth game. A new ethic of sustainable development must favour a humanistic and cross-cultural approach on progress that cannot be reduced to the accumulation of material goods. The present dynamics of representative democracy is limited to meet demands of orthodox economics and a false conception of prosperity --linked most of the time to the myth of unlimited growth and a conception of men as a free consumer--. But prosperity cannot be reached just by playing the growth game. A new ethic of sustainable development must favour a humanistic and cross-cultural approach on progress that cannot be reduced to the accumulation of material goods. The present dynamics of representative democracy is limited to meet demands of orthodox economics and a false conception of prosperity --linked most of the time to the myth of unlimited growth and a conception of men as a free consumer--. But prosperity cannot be reached just by playing the growth game. A new ethic of sustainable development must favour a humanistic and cross-cultural approach on progress that cannot be reduced to the accumulation of material goods. The present dynamics of representative democracy is limited to meet demands of orthodox economics and a false conception of prosperity --linked most of the time to the myth of unlimited growth and a conception of men as a free consumer--. But prosperity cannot be reached just by playing the growth game. A new ethic of sustainable development must favour a humanistic and cross-cultural approach on progress that cannot be reduced to the accumulation of material goods. The present dynamics of representative democracy is limited to meet demands of orthodox economics and a false conception of prosperity --linked most of the time to the myth of unlimited growth and a conception of men as a free consumer--. But prosperity cannot be reached just by playing the growth game. A new ethic of sustainable development must favour a humanistic and cross-cultural approach on progress that cannot be reduced to the accumulation of material goods. The present dynamics of representative democracy is limited to meet demands of orthodox economics and a false conception of prosperity --linked most of the time to the myth of unlimited growth and a conception of men as a free consumer--. But prosperity cannot be reached just by playing the growth game. A new ethic of sustainable development must favour a humanistic and cross-cultural approach on progress that cannot be reduced to the accumulation of material goods. The present dynamics of representativen...
a common goal in the development of future scenarios and collective solutions for realizing a low carbon society. Together with several Asian researchers we have been carrying out analyses of the various initiatives with a focus on low carbon society. Based on our integrated assessment model, the Asian Integrated Model (AIM), as a common tool of analysis, quantitative visions and roadmaps to achieve the 2 degree target have been investigated, and results were shared among researchers in Asia. The researches in Asia have been applying the AIM to analyze low carbon future targets and optimal roadmaps for their countries. They have been sharing results and the implementation process in order to design responsible solutions to national low carbon policies, infrastructure plans, eco-model city designs, and industrial transformation characteristics. During all these collaborative research network activities, scientific methods were developed, test cases, simulation models with and evaluation indicators have been shared, investigated and refined. Moreover, these international research platforms have already made tremendous contribution to comparative analysis of socio-economic characteristics among different countries, and to actual policy making process through dialogues between stakeholders and researchers. The purpose of our presentation is to demonstrate, firstly, the structure of the AIM as the integrated future scenario simulation system toward analyzing low carbon society and developing roadmap to achieve 2 degree target. Secondly, we will showcase examples of transformative actions towards low carbon society in some countries. The examples include project designs that lead to green city such as low carbon new city development plan. Thirdly, from our experiences of the international research activities, we will show the importance of scientific analysis based policy discussions. Fourth, we will demonstrate the use of monitoring and observation system in order to validate future scenarios for low carbon society and develop roadmap to achieve 2 degree target. Finally, by combining all these efforts, the presentation will highlight Asian example as a reference for rest of the world in regional cooperation, collaborative process of developing integrated tools and common solutions to realize low carbon society.

Vulnerabilities and threat models on smart grid cyber security: A survey

KD. Muthavinhe (1)
(1) Tshwane University of Technology, Pretoria, South Africa

When smart grid was invented, two out of many main purposes were to have self-immune on vulnerabilities and threats posed on it. Lot of thread models have been developed to achieve these purposes on smart grid but up-to-date there is no better achievement [1]. These vulnerabilities and threats are pose low attackers on the building blocks of smart grid like, meters, communication media, billings, electrical transmission, power generators etc [2]. When these components are being maintained, they give loop whole to pose vulnerabilities and threats [2]. These attackers want to analyze plan inadequacy, poor design in components or building block in order to steal identity of end user, conduct deception and diversion. These vulnerabilities and threats are not clearly known by many researchers, some of them are not listed anywhere [2]. These leads the question that do threat low thread models to mitigate these vulnerabilities [1]? To answer these questions we first conduct a survey. Albeit there is no other project that encompasses on vulnerabilities and threat models on smart grid cyber security: A survey.

In this project proposal we will survey, discuss and summarize new threats and vulnerabilities on smart grid cyber security after that we will survey the already developed threat models or solutions on smart grids cyber security and compare their strengths and weakness. These will be measured by checking if one threat model can mitigate these vulnerabilities, how these vulnerabilities and thread models will be provided. After that indication of where improvement will be done in all models is going to be indicated in the conclusion of the paper.

Definition of threat modeling

This is a solution that recognizes a set of vulnerabilities (potential attacks) on a specific product or system and precise how these attacks might be inflicted and the best technique of blocking potential attacks. Threat models are used as input to the creation of test plans and cases [1].

References

2. Lesley and Sanjay (2013) Smart Grid Security – Privacy Concerns

P-4414-15

«Warming and Greening»: An assessment of farmers’ capability to curbing water disasters in Muooni Catchment, Kenya

C. Ngono Luwesi (1)
(1) Kenyatta University, Geography, Nairobi, Kenya

In the 16th century B.C. Moses the prophet saw «a burning thornbush» that was not consumed. This account has thriled many of us for centuries beyond any imagination. Thanks to recent scientific knowledge, which has unveiled such a phenomenon «Warming and Greening»: effects of climate change is a threat to life supporting ecosystems, and particularly to forests and freshwater resources. This study puts in motion Moses’ account of the “burning thornbush” in the ecosystem similar to that of Mount Hored: the semi-arid and hilly Muooni Catchment of Kenya. The research used rigorous scientific methods and tools to assess vulnerability and capability to curb exposure to hydro-meteorological hazards, social risks and economic misfortunes facing farmers in the course of climate change. The study used innovative and integrated Vulnerability-Capability Assessment (VCA+) techniques for agricultural water adaptation to climate change. Results from the study show without any contradiction that farmers living in Muooni Catchment are most susceptible to (flood than drought). This can only be attributed to the high risks of changing hydro-climatic conditions triggered by ill-planned land-use activities and subsequent environmental changes, which are also linked to the global warming, to sea surface temperature rise, high ocean currents and atmospheric wind pressure occurring in the southern hemisphere, and which are commonly known as El Niño (flood) and La Niña (drought). These effects are well known to impact on the farmland productivity and the sedimentation of water channels. However, it comes out from the analysis that individual farmers’ capability to adapt to future disasters will largely depend, not on their endowed capacity (or resources) but on the integration and preparedness of their community to disasters. These factors combined with high investments in water infrastructure, operations and maintenance may lead to water and land scarcity. Farmers hence need to incorporate these drivers, risks and impacts in their decision making for their future investments and adaptation to environmental changes. This may enhance their capability to manage water resources and subsequent institutions thus decreasing their vulnerability to water shortages. Moreover, a green economy has been propounded to be a true paradigm shift from “as usual” (BAU) to behaviour change and climate adaptation. This may contribute to preserving our forest and freshwater reserves under threat of greenhouse gases emission and increasing surface temperature rise. All stakeholders are invited to cooperate in environmental conservation through adjustment of their lifestyles and land use activities, owing to uncertain climatic vulnerabilities. Whether acting independently (“autonomous” adaptation programme) or collectively (“planned” adaptation programme), farmers are called to increase their adaptive capacity and ability as a community to respond to climate risks and impacts and take advantage of the benefits arising from a green water economy under «Warming and Greening».

P-4414-16

Obstetrics Risk of HIV infection among women attending antenatal clinic in General Hospital Suleja, Niger State, Nigeria

MU. Okoje (1)
(1) FCT COLLEGE OF EDUCATION ZUBA, ABUJA, NIGERIA. REPRODUCTIVE HEALTH EDUCATION, ABUJA, FEDERAL CAPITAL TERRITORY, Nigeria, Federal Republic of Nigeria.

Background: Obstetrics risk and practices can lead to the prevalence of AIDS. Identifications of such obstetrics risk of HIV infection is a useful step in the prevention of transmission of the virus. Objective: The research sort to determine obstetrics risk of HIV infection in pregnant women attending antenatal clinic in General Hospital Suleja, Niger State. Methods: The researcher conducted a cross-sectional descriptive study of pregnant women attending antenatal clinic in General Hospital Suleja, Niger State between August and December, 2014. Data were collected using structured questionnaire. HIV screening and confirmation was carried out on pregnant women after voluntary counseling. Results: 350 pregnant women were enrolled with a mean age (+ or-SD) of 26.8+ or- 6.4 years. The highest number of HIV infected women was observed in those who had their first coitus between 16 and 20 years. The age at first coitus was significantly related to the HIV infection (P=0.41). Neither parity (P=0.13) nor past history of abortion (P=0.42) was associated with HIV infection. Non of the 41 women who had their last delivery at the hospital had HIV infection while 22.2% of those who delivered under the same hospital but had attended birth attendant had HIV infection. Conclusion: Obstetrics practices may encourage transmission of HIV infection. This calls for re-examination of the obstetrics practices especially in innovative social technology centres in order to prevent transmission of HIV infection.

P-4414-17

Effectuating Humane Societal Transformation through Effective Collaborative Governance - A Holistic System-Cybernetic Model

J. Ostergaard (1)
(1) Malik, Global Transformation Initiatives, St. Gallen, Switzerland.

In order to ensure reliable governance and control of the Great Transformation 21 (The paradigm for the special kind of change called substitution or creative destruction) Malik is providing the most advanced systems, tools and methods for mastering complexity and ensuring effectiveness.

While in earlier times, societal revolutions were induced by groundbreaking technological innovations, today social technology of system-cybernetic management will revolutionize the functioning of both companies, societal organizations and whole countries.

The Malik Governance Systems® - Management operating systems of a new era Management for people and management for organizations are the fields of application of Malik’s holistic management and governance systems. These systems create the conditions in which people can effectively transform their own strengths into performance, thus achieve their goals, see meaning in what they are doing and find fulfillment.

The Malik Governance Systems® have unique characteristics that enable people and organizations to overcome any management challenge. The Syntegration® methodology is at the heart of the transformative power of Malik’s holistic management and governance systems. While in earlier times, societal revolutions were induced by groundbreaking technological innovations, today social technology of system-cybernetic management will revolutionize the functioning of both companies, societal organizations and whole countries.

During a Syntegration the knowledge of a large group of people is effectively combined. Executives around the world apply it for developing solutions to their most complex challenges and for simultaneously achieving strong commitment and fast implementation. The basic model for the functioning of Syntegrations is the most complex platonic solid, the icosahedron and its geometrical-mathematical properties. These determine the logic of the communication linkage of large groups of people.

The Syntegration approach allows highly complex challenges, often interconnected across the whole organization or even across sectors of society to be mastered quickly, effectively, cheaply and holistically. This requires the simultaneous collaboration of all of the specialists who, when networked together, have the necessary knowledge to find solutions for the problems.

The results of the Syntegration include the following two effects: on the one hand, it leads to innovative solutions by releasing the existing creative intelligence in the system, and by making full use of all available knowledge. On the other hand, the hierarchy-free participation of all those involved mobilizes the social engagement required for
for efficient, accurate and speedy implementation. The effectiveness and speed of this method are much higher than with conventional methods. It works without the periods of inactivity, which usually occur at big events, and with a precision hitherto regarded as impossible in change management.

The Syntegration method proved its high level of efficiency and reliability in more than six hundred applications across societal domains and issues (e.g. Food, Energy and Automotive), Science (e.g. Helmholtz Institute and German Cancer Research Center), GOV (e.g. Cities, Higher Education and HealthCare) and clusters of same (e.g. SolarValley, an internationally established cluster of photovoltaics (PV)).

**P-4414-20**

**Strengthening Nomadic Herders' Traditional User Groups for Sustainable rangeland management in Mongolia**

EA. Tseelei (1) ; D. Maselli (1)

(1) Swiss Agency for Development and Cooperation in Mongolia, Green Gold Project, Ulaanbaatar, Mongolia

Nomadic livestock herding has been the livelihood of many Mongolians for centuries. For countless generations, herders have lived in harmony with the fragile and sensitive ecological systems of the semi-arid and arid rangelands which make up 80 per cent of the country’s total land area. Rotational grazing between four seasonal rangelands and water access combined with the balancing of livestock numbers to suit the carrying capacity enabled rangelands to regenerate, as did the setting aside of reserve areas for use during emergencies and natural disasters. These have been the core practices of nomadic herding that have ensured long-term environmental sustainability.

At the start of the transition period, there was a rapid increase in the number of ‘new herders’ – many of whom were former state employees who had lost their jobs and turned to herding as a means to support themselves and their families. Since then, the number of herder families has doubled, as has the number of livestock. The use of public rangelands, however, has remained unregulated and can be used by anyone. This has had a number of negative consequences: Chaotic and opportunistic behaviour in rangeland use at the expense of traditional herding norms and circularity, the immediate incentives to increase animal numbers without regard for quality; and discouraging an ownership mentality and impeding the initiatives of herders and local governments, providing opportunities for local elites to secure exclusive rights to productive rangelands, which generates inequality and endangers the sustainable foundation of herders’ livelihoods.

In the mid-2000s, the Mongolian government began to take measures to address the problem and to ensure the proper use of public rangelands, with the first Land Law enacted in 2006. Under the Land Law, herder families with shared access to seasonal rangelands and organised on a voluntary basis to collectively manage the land are able to negotiate Land Use Agreements with local authorities. To ensure more effective implementation of the Land Law, the government adopted an annual local land-management planning methodology in which local governments are required each year to draft rangeland use plans, to be implemented through mediation and with the participation of the herding community. Despite this initiative, the implementation of the Land Law and the planning methodology has proved to be insufficient, largely due to the poor capacity at the local government level and inconsistent government policy resulting from increasing conflicts of interest that favour the issuing of mining licences on former rangelands. In addition, raising awareness and capacity development at the level of herder households is a time-consuming task.

Since 2008, the Green Gold Project, in cooperation with local governments, has supported herders’ traditional user groups – Pasture User Groups (PUGs) – in order to develop the capacities needed to collectively develop and implement grazing plans and regulate the use of common seasonal rangelands. In the intervening years, about 1000 PUGs have been supported. By September 2014, about 400 of those PUGs had negotiated land-use agreements with local authorities based on collective rangeland use plans and the adoption of internal regulations. In those soums where herder families have become organised and have adopted collective rangeland use plans and regulations, the implementation of the Land Law and the planning methodology has become more feasible. The division of responsibilities between herders and local governments in managing rotational grazing, stocking rates and the management of hay-making and reserve areas has become clearer and is thus better implemented and monitored.

At present, PUG Land Use Agreements are the only legal documents assuring herders of their traditional user rights to their rangelands.

**P-4414-19**

**The Sustainable Energy Utility as a transformative solution to ‘utility 2.0’**

J. Taminiau (1); J. Byrne, (1)

(1) University of Delaware, Center for Energy and Environmental Policy, Newark, Delaware, United States of America

Economic development decision-making criteria throughout the 20th century relied heavily on economic optimality as a chief guiding principle in the design of energy, technology, markets, and policy. Proposals to redefine energy progress on sustainability principles gives rise to an emerging 21st century sustainability paradigm reviving around commons-based economics and a long-term ecological viability. An existing operational expression of the new paradigm – the Sustainable Energy Utility (SEU) [1],[2] – is analyzed as a practical means to arrive at the New Economics and New Policy which might guide the energy sector under a 21st century sustainability paradigm. The SEU is compared and tested against other candidates for ‘utility 2.0’, most notably the Energy Service Utility in order to establish the transformative potential of the SEU application.


Our Common Future, Our Common Global. Approaches from an educational experience towards collective action

MB. Wehbe (1); M. Juarez (2)
(1) Economic Science, Economy, Rio Cuarto, Cordoba, Argentina; (2) Humanities, Psycopedagogy, Rio Cuarto, Cordoba, Argentina

‘...When we understand how much we depend on nature then we will start this huge cultural change we need to be more sustainable...’ – Antonio Tironi Silva, Young Scientists Network Conference, Villa Vignoli, Italy, 2014 (Video available at www.iscu.org)

A common future under climate change will need deep behavioural changes. We need to learn more about threats and risks, to reduce vulnerabilities, to increase our capacities to adapt to global environmental changes, and to reduce our pressure on the environment. We need to sustainably live under uncertainty within a complex human–nature world.

We can think about climate change as a major threat to humans and nature, a threat to our common future, a tragedy of our global commons. Despite quite strong, short term global actions are required if we are to avoid this and other threats to and from global environmental changes, equally strong but long term individual and collective behavioural changes will be necessary.

This presentation is about an educational experience aimed at fostering behavioural changes at the individual level and towards collective action. We present results from a local experience through formal education at the National University of Rio Cuarto in Argentina. An ongoing Project (PRODEC*) which aims at introducing environmental issues within all discipline curricula at our University based on the premise that most of our students are those future professionals and educators that at different levels and within different spaces will have the opportunity and hard challenge to foster that huge cultural change we need to sustain life on Earth.

The Project started in 2013 with the integration of professors from different disciplines, within the social and natural sciences, interested in an interdisciplinary approach to global environmental changes and challenges through formal education. The Project has been associated to a request from the Humanities school at our University to offer an education in “education for the environment”. To date, four workshops have taken place: one with undergraduate students from our University; one with students from primary education; and the other two, with students from first years of secondary school. In all cases, each workshop was structured in three phases: a) an oral presentation accompanied by allusive photographs, pictures and diagrams to the presented global environmental threats and challenges; b) the development of competitive and cooperative games; and, c) a space for creativity from group productions (posters made by students) related to what has been experienced, followed by a fifteen minutes presentation by group. Each workshop started with an impersonal individual written inquiry about their expectations for the workshop and ended with another individual appreciation on what has been experienced, in a written form.

Main results from these participative experiences may be summarized as follows: a) all students show themselves eager to learn more about what is going on at Planetary scale concerning the relationship human–environment; b) there is a widespread willingness to reconnect to nature –i.e. through different activities within and outside the University; and, c) there is a kind of widespread hidden disappointment, a discovery of the possibilities to solve problems through collective action.

To date, these experiences have allowed our working team to increase our expectations on introducing environmental issues within all discipline curricula at our University through this type of workshop activities, even we have not been able to assess the extent to which these activities may have transformed students behaviour yet.

* PRODEC Team: Rached S; Aguilar Mansilla F; Echenique H; Tello D; De Luca N

Dynamic of agricultural innovations diffusion in Burkina Faso

B. Zongo (1); D. Abdoulaye, (2); B. Barbier (3); D. Thomas, (4)
(1) International Institute for Water and Environmental Engineering (ZIE), Ouagadougou, Burkina Faso; (2) International Institute for Water and Environmental Engineering (ZIE), Laboratoire d’hydraulogie et des ressources en eau, Ouagadougou, Burkina Faso; (3) CIRAD, Umr geau, Dakar, Senegal; (4) Université de Liège, Department of rural economic and development, Gembloch, Belgium

This study highlights the factors determining the spread of agricultural innovations for water harvesting since the drastic effects of drought 70s in Burkina Faso. These innovations include zai, stone bunds, bunds land, half-moons, mulching and grass strips. A survey of 629 farmers revealed that farmers fall into five categories which are the pioneer, early, latecomer, late and non-adopters. After four decades of diffusion (1974–2013) the rate is estimated at 65.3% for stone bunds, 49.1% for zai, 26.2% for grass strips and less than 10% for half-moons, bunds land and mulching. The multinomial logit model showed that the climatic conditions in the Sahel zone, age and perception of innovations by farmers households promoted the spread of these innovations. However, the low level of organization and access to agricultural services were the major constraints to their adoption.
Urban sprawl and mobility are currently becoming an important concern in developed countries and represents a principal constraint in Europe concerning the reduction of greenhouse gas emissions. Nonetheless, in sub-Saharan Africa where household's motorization rate is still weak, the main issue appears to be inadequate transport. This communication aims at shedding light on integrated land use and mobility planning actions with a focus on reducing vehicle emissions, introducing clean fuel and clean vehicle technologies, improving fuel economy and reducing CO2 emissions.

Estimates by Godard (2002) for some cities in Africa indicate that CO2 emissions rate is weaker than certain capital cities in Europe. However, studies by CERTU and STC (2002), redone by Duprez (2002), highlight the interest of this question by comparing greenhouse gas pollution between cars and public transport. This comparison found that high cost vehicles associated with small size low cost vehicles in Abidjan. Results indicate that, these taxes reject more CO2 emissions than minibuses and buses.

This contribution using the city of Yaoundé with a mon soldier spatial form, as a case study, aims to show how accessibility is created through the link between urban form and transport services. The aim of the paper is to evaluate accessibility policies by measuring the consequences of urban sprawl on the production of greenhouse gas emission, within the context of an African context, with a time frame of 1990. The study has not been adopted as a pertinent solution for urban displacement. Using data from the third Cameroon household consumption survey (2007) and the urban displacement plan for Yaoundé (2010) describing mobility is realized by individuals on a daily and weekly basis, the study estimates the rate of CO2 emission according to characteristics associated to displacement as well as urban form.

The main finding of the estimation is that CO2 emissions is linked to mobility practices associated to distance covered. Consequently, urban transport and land use planning in Yaoundé are not CO2 neutral. The mono centric spatial form of the city of Yaoundé with a spatial concentration of services and economic activities, low residential density likely induces high level of travel demand. Associated with high emission of greenhouse gas services, induces high level of CO2 emissions. The main policy agenda should be the necessity to insist on putting in place an integrated and transport infrastructure and services.

K-4415a-02

The EASI (Enable, Avoid, Shift, Improve) concept: a climate-friendly policy framework to ensure accessibility and sustainable mobility in urban areas of developing countries

J.C. Crochet (1)
(1) CODATU, Angers, France

The objective of this presentation is to discuss the results of a major study recently carried out under the aegis of the SSATP. The objective is to provide an overview of the current situation in urban transport in developing countries and, second, to present policy measures in order to address these constraints. The constraints are based on a systematic and thorough data collection effort of a scope never carried out before. Twenty cities (metropolitan areas in fact) were selected for the data collection. A detailed set of information in eleven domains was collected for each city in the same format.

The key weaknesses that were identified were the following: (i) inadequate governance systems, although there was a lot of variability in this among the cities; (ii) little progress with respect to land-use planning and control and their integration with the development of mobility systems; (iii) insufficiency of the transport system optimization of the various transport modes; (iv) unplanned development of informal, environmentally unsound, small public transport providers; (v) serious deficiencies in the design of infrastructure and in operation and maintenance; (vi) high level of traffic accidents; and (vii) neglect for the environmental impact of transport and the resilience of cities. A major consequence of these weaknesses is that urban growth produces much greater GHG emissions and transport services are not sustainable.

The presentation will then discuss the key elements of the policy framework needed to address the above issues. It will show that the ASI (Avoid, Shift, Improve) conceptual framework formulated about ten years ago to structure public action mostly in developed countries is fully relevant to African and developing world cities as long as it is adapted to the particular context of these cities. This requires that special emphasis be given to the future urban form and future infrastructure networks (including their resilience) in the “Avoid” actions, to an integrated and inclusive multimodal mobility strategy focused on non motorized transport and low cost public transport in the “Shift” actions, and to more efficient traffic and vehicles in the “Improve” actions.

The presentation will also emphasize that, for public action to be effective, it is essential to establish a competent and responsible governance framework for urban transport in Africa, which will lead the transformation effort in conjunction with all stakeholders, therefore to add a set of “Enable” actions. This framework should be capable of anticipating needs, guiding action, and ensuring integrated management and development of urban transport systems. It would include the adoption of a national urban transport strategy, the adequate allocation of responsibilities at the urban and metropolitan levels, the setting up of metropolitan transport agencies in the large cities, the fast development of human resources, the sustainable increase of financing flows to urban transport, the continuous participation of civil society in the development of urban transport systems and the involvement of the private sector in the provision of transport infrastructure and services.

K-4415a-03

Urban Agenda for Climate Change- Meeting the mobility needs of urban poor

R. Sharma (1)
(1) Housing and Urban Development Corporation Ltd., Human Settlement Management Institute, Delhi, India

India is at the doorstep of rapid urbanisation. The process of urbanisation is contributed by migration of population, with diverse socio-economic and cultural backgrounds, to cities. One common aspiration they all come with is quality of life. Although 20% of the GDP of the two-third of total GDP, the flow back for city improvement is very meagre. City infrastructure is getting overstressed with the added burden of migrants. City is unable to meet the demands of migrants for housing, urban services, employment and social security. The result is islands of disparity and social divide between different segments of population on the basis of origin, socio-economic fabric and religion.

Owe the years, many attempts have been made to integrate population living in various clusters of the city. Inclusive planning is a tool, which provides opportunities for the residents to plan for their social, physical, cultural and socio-economic needs. In order to provide opportunities for the residents to plan for their social, physical, cultural and socio-economic needs. Urban transport is an important entry point towards achieving the objective of inclusive planning, for the simple reason that it cuts across all the sectors and population. Mobility is directly linked to interaction of various stakeholders, which is a precondition for generation of GDP. Mobility also consumes large resources and leads to high levels of carbon footprints.

This session would look into various planning imperatives pertaining to urban transport, with an objective of making a city ‘inclusive’ and environment friendly. Discussions
would focus on formulating strategies to make transport accessible to the urban poor, with an objective of reducing carbon footprints. Tools like integrated transport network, last mile connectivity, transport demand management, transport oriented development, transport pricing etc would be illustrated to demonstrate their adaptability in meeting the needs of urban poor in the making of inclusive and carbon neutral cities.

**O-4415a-01**

**Sustainable Urban Mobility Plans: a local approach for national mitigation actions**

J. Allaire (1); T. May, (2)

(1) CODATU, Lyon, France; (2) Institute for Transport Studies, Leeds, United Kingdom

In European countries, Sustainable Urban Mobility Plans (SUMP) have shown how much they could be a powerful full approach to define urban transport policies that combine the multiplicity of transport modes and their actors.

In its international review, the European Conference of Ministers of Transport (ECMT, 2002) highlighted the principal barriers to effective SUMP development as poor policy integration and coordination, counterproductive institutional response, and regulatory frameworks, weaknesses in pricing, poor data quality and quantity, limited public support and lack of political resolve.

Thanks to Nationally Appropriate Mitigation Actions (NAMA) there is an interesting potential to develop mitigation policies in developing countries by combining local urban transport planning and national policies.

The concept of the NAMA – Nationally Appropriate Mitigation Action – emerged in December 2007 during the 13th session of the Conference of the Parties in Bali (COP13) and it was detailed in the Cancun agreement in 2010. NAMAs are voluntary measures taken by developing countries – and registered by the UNFCCC – to reduce their GHG emissions. Not only do they cover investments that directly reduce GHG emissions, they also cover investment projects and programmes, as well as sector-based or national policies to reduce emissions in the medium and long term.

They must refer to a real-time situation and show the expected reductions in GHG emissions using MRV methodology (Measure, Report, Verify) to quantify the impact of the measures taken. But they have also to report on co-benefices such as accessibility improvements, congestion reduction, air quality, road safety, public health, etc.

By using a national MRV (Measure, Report, Verify) methodology, the local authorities could monitor and evaluate the impact of their mobility policies within a SUMP process, but their effort could also be encouraged at the national level, by national support and appropriated legislative framework before being submitted to the UNFCCC secretariat.

Such Vertical NAMAs in the urban transport sector could certainly facilitate sustainable urban development in developing countries and give to urban transport a transformational role for cities.

**O-4415a-02**

**Transforming a Megacity: Climate Change Adaptation and Mitigation in Jakarta**

EB. Kurniawan (1)

(1) Ministry of Public Works and Housing, Jakarta, Indonesia

Recently, Jakarta has been selected as a city with the worst traffic jam in the world. As large as urban areas in the world, the city suffers various urban problems on extreme levels. In 2010, it has 771 traffic congestion points and 11,185 1/s water supply deficit. It is also struck by flood every year. Flood does not only come from the upstream areas but also from the sea. Some of its northern coastal areas experience rapid land subsidence with 7.5 cm/year on average. It is predicted that if nothing be done, water from the sea will go up into the heart of the city in less than 50 years. The rapid urban population growth in Indonesia, especially in Greater Jakarta, makes the problems in the future worsening.

The 5th Assessment Report describes how urban areas are strongly related to the climate change. It contributes significantly to CO2 emissions. Urban form and transport infrastructure, as well as density and mixed use of land use are strongly related to GHG emissions. They also have a strong link to the level of efficiency in the use of energy.

This paper explains how the Indonesian government addresses those problems, their strategies and to what extent they already implement such efforts. Do they handle it in a comprehensive manner? Which efforts can be considered as climate change mitigation, adaptation and both? Such questions will be answered here.

The central government of Indonesia comes up with the concept of Green City, not only for Jakarta but also for other Indonesian big cities. The concept requires that a city in Indonesia needs to focus in improving the condition of eight elements, namely Green Space, Green Waste, Green Energy, Green Water, Green Transportation, Green Building and Green Community.

In the case of applying the concept, the government is on the way of mainstreaming climate change into spatial planning. In the case of Jakarta, it tries to cope with the increasing number of motorized vehicles on the roads and the worsening traffic congestion by improving the public transport condition through the development of Bus Rapid Transit (BRT) and Mass Rapid Transit (MRT). The government also tries to connect the implementation of such public transport network with the densification of land use and the application of mixed use by implementing the transit oriented development (TOD) concept.

As for the problem of land subsidence and the sea level rise, the government has a plan to build the so called Giant Sea Wall, which can protect the coast of Jakarta and to function as rainwater storage. In addition, Jakarta is also increasing the size of its green open space. It may reduce the flood and at the same time cooling the city’s temperature. Therefore, Jakarta is and will be experiencing a big transformation in order to overcome its problems as well as ways of climate change mitigation and adaptation.

**O-4415a-03**

**Comparative resilience process of Asian river / coastal cities faced with hydraulic crisis**

C. Pierdet (1)

(1) Université de Technologie de Compiègne – COMUE SORBONNE-UNIVERSITÉS, Umr 8591 Igp (meudon), FRANCE, France

The Asian coastal or river cities are already subject to very high hydroclimatic stress, to the point that public investors reject in the outskirts of cities the flood of 1996. They have been badly damaged during the Khmer rouge régime.

In Bangkok Metropolitan Area (BMA), despite the many evolutive projects, the flood of 2011 have been rebuilt only after the great flood of 1996. They have been badly damaged during the Khmer rouge régime.

In Bangkok, the central government of Indonesia has set up the Ministry of Public Works and Housing (MOP) to manage the worst traffic jam in the world. As large as urban areas in the world, the city suffers various urban problems on extreme levels. In 2010, it has 771 traffic congestion points and 11,185 1/s water supply deficit. It is also struck by flood every year. Flood does not only come from the upstream areas but also from the sea. Some of its northern coastal areas experience rapid land subsidence with 7.5 cm/year on average. It is predicted that if nothing be done, water from the sea will go up into the heart of the city in less than 50 years. The rapid urban population growth in Indonesia, especially in Greater Jakarta, makes the problems in the future worsening.

The 5th Assessment Report describes how urban areas are strongly related to the climate change. It contributes significantly to CO2 emissions. Urban form and transport infrastructure, as well as density and mixed use of land use are strongly related to GHG emissions. They also have a strong link to the level of efficiency in the use of energy.

This paper explains how the Indonesian government addresses those problems, their strategies and to what extent they already implement such efforts. Do they handle it in a comprehensive manner? Which efforts can be considered as climate change mitigation, adaptation and both? Such questions will be answered here.

The central government of Indonesia comes up with the concept of Green City, not only for Jakarta but also for other Indonesian big cities. The concept requires that a city in Indonesia needs to focus in improving the condition of eight elements, namely Green Space, Green Waste, Green Energy, Green Water, Green Transportation, Green Building and Green Community.

In the case of applying the concept, the government is on the way of mainstreaming climate change into spatial planning. In the case of Jakarta, it tries to cope with the increasing number of motorized vehicles on the roads and the worsening traffic congestion by improving the public transport condition through the development of Bus Rapid Transit (BRT) and Mass Rapid Transit (MRT). The government also tries to connect the implementation of such public transport network with the densification of land use and the application of mixed use by implementing the transit oriented development (TOD) concept.

As for the problem of land subsidence and the sea level rise, the government has a plan to build the so called Giant Sea Wall, which can protect the coast of Jakarta and to function as rainwater storage. In addition, Jakarta is also increasing the size of its green open space. It may reduce the flood and at the same time cooling the city’s temperature. Therefore, Jakarta is and will be experiencing a big transformation in order to overcome its problems as well as ways of climate change mitigation and adaptation.
ABSTRACT BOOK

4415b - Transformative solutions for urban sustainability governance: Multi-level government and cross-sectoral collaboration for effective and efficient climate action

ORAL PRESENTATIONS

K-4415b-01
Transformative solutions for urban sustainability governance: Multi-level government and cross-sectoral collaboration for effective and efficient climate action

T. Elmqvist (1)
(1) Stockholm University, Stockholm resilience centre, Stockholm, Sweden

In this session we will focus on transformative solutions for urban sustainability governance. After more than two decades of attempting to address climate change and broader sustainability challenges through a global regime, progress has been largely incremental and piecemeal. Despite a rich theoretical tradition that increasingly addresses the normative issues in global environmental governance, and considers the crucial role of non-state actors, the application of this theory to practice often retains a biophysical or managerial lens rather than a deeply normative or socio-political one. Transformative actions are emerging, however, that may deepen resilience and trigger effective climate change adaptation and mitigation. These actions are particularly abundant at the urban scale, drawing upon novel constellations of actors, resources, and engagement strategies.

Responding to the global environmental challenge requires a deepened understanding of how urban areas relate with the environment and how they transform it. New areas of research are needed that explore the dynamics of urbanization, including the globalization of urban lifestyles and diets, which must take into account urban complexities and urban resilience for refurbished governance and urban transformations.

Collaborative engagement that includes non-state actors, non-governmental networks and civil society provides a deeper and better understanding of the complexity that comes with bridging human and biophysical dimensions of environmental policy, including social-ecological dynamics, in order to bring about sustainable development in urban contexts. This requires a shift in thinking within governance that embodies transformative pathways – with the international tools in hand (i.e., MRV regulation, transparent reporting of climate action), as well as deeper engagement with a variety of stakeholders to help build a meaningful, legitimate, and ultimately effective mode of ‘urban sustainability governance’.

To this end, this panel brings together key scholars and leading experts on local government climate action to propose new insights into participatory, inclusive action that engages non-state actors.

The session proposed will be focused on urban environments (cities) and their climate action transformations. Examples of successful transformative dynamics and solutions tested in and demonstrated by cities will be highlighted. The session includes new insights into community-based action research on climate change; guiding principles in governance at multiple scales for efficient urban transformations; the drivers of unsustainable development paths; collective action with involvement of diverse knowledge-and-power domains and multi-stakeholder engagement towards creating transformative pathways at the local level; and approaches to standardized, transparent emissions reporting.

O-4415b-01
Urbanisation, sustainability and transformation - from local decisions to global goals

B. Webb (1); X. Bai (2); M. Stafford-Smith (3)
(1) Australian National University, Fenner School of Environment and Society, Canberra, Australia; (2) Australian National University, Canberra, Australia; (3) Climate Adaptation Flagship – CSIRO, Black Mountain, Australia

Urbanisation with its attendant resource and social pressures is an increasingly dominant feature of development. Substantial research addresses sustainable urban development. However, whilst there are important attempts at integration, from a ‘whole of systems’ perspective much of the research has been partial and fragmented. Understandably, public and private sector decision makers find it difficult to encompass the full range of issues, whilst also facing a range of risks and uncertainties (including, but not only, climate change).

With much of the growth in urbanisation still to come, there is a window of opportunity to address the complex and multi-level issues from the local, regional and national decision-makers perspective. At the same time development of the UN Sustainable Development Goals, many directly relevant to urban directions, provide an overall context to address the many trade-offs and synergies faced in practice by urban decision-makers.

The presentation describes an initiative currently under development to use a wide range of Asian and Australasian urban case studies to systematically investigate:

- the extent of two-way interactions between urbanisation and sustainable development goals at local, regional and global levels

- identification and analysis of the most critical trade-offs and synergies, and the transformational preconditions identified, can be related to various urban characteristics and typologies; this to better understand the potential for (and limitations in) transferability of insights, learning, practices and strategies.

- the extent to which the key choices, trade-offs and synergies, and the transformational preconditions identified, can be related to various urban characteristics and typologies; this to better understand the potential for (and limitations in) transferability of insights, learning, practices and strategies.

It is crucial to reveal and understand these key inter-linkages, which are not always apparent, but can present both challenges (unintended outcomes or even derailment of an intervention) and opportunities (identifying the leverage points for generating and realising co-benefits). The initiative will aim to provide practical integrated cross-sector guidance to urban decision-makers at various levels, on the key strategic issues and choices they face, and relevant to their context. It also aims to develop underpinning scientific insights including a robust set of frameworks that will facilitate understanding and analysis of the impacts of various urbanisation choices and futures, at multiple levels of analysis, and so contribute more generally to future research methodology and practice.

The approach to be taken to the initiative includes analysis through research and stakeholder partnerships and collaborations with a diversity of case study cities and sectors to be included; trans-inter-disciplinary approaches including knowledge co-design/development with stakeholders, recognising that multiple decision makers and other stakeholders need to be engaged to reflect the initiative’s decision-centred approach; viewing cities as
urban transiti¬ons are complex and shockwise processes of change occasioned by formal and informal types of governance. This presentati¬on draws from the experiences with urban transiti¬on labs to reflect upon the dynamics of urban sustainability transiti¬ons, its inherent strengths and priorities, and catalyze broader international initiatives, including Future Earth. O-4415b-02

Urban transitions
D. Loorbach (1)

(1) Dutch Research Institute for Transitions, Rotterdam, Netherlands

Urban transiti¬ons are complex and shockwise processes of change occasioned by formal and informal types of governance. This presentati¬on draws from the experiences with urban transiti¬on labs to reflect upon the dynamics of urban sustainability transiti¬ons, its inherent strengths and priorities, and catalyze broader international initiatives, including Future Earth. O-4415b-02

Driving change through effective local climate action, collaboration and integrated solutions
A. Marques (1) ; A. Pickens (2) ; Y. Arikan (2) ; M. Van Staden (1)

(1) ICLEI – Local Governments for Sustainability, Low carbon cities / carbonn climate registry center, Bonn, Germany; (2) ICLEI – Local Governments for Sustainability, Global policy and advocacy, Bonn, Germany

Setting the scene for inclusive and decisive global climate regime is not done in an isolated manner. Transformative climate action requires multi-level government and cross-sectoral collaboration for ensuring low-emission, climate-resilient development in the urban world.

Local Governments can have significant impacts on local markets and on the large-scale delivery of low emission development technologies and practices, through their mandates and different roles as policy maker, regulator, service provider and consumer (procurement processes).

This presentation focuses on the change system which is being implemented by ICLEI – Local Governments for Sustainability and other local government networks, from the definition of a common global vision and strategy that enables the recognition, engagement, and empowerment of local and subnational governments, to the main methodologies and tools used for the collaborative identification of transformative pathways at local level. Results are presented and key barriers and opportunities are identified and discussed.

This presentation also explores the different processes, methodologies and tools ICLEI uses to identify the local urban change priorities, and catalyze broader engagement from different actors, including the business community, to foster the development of long-term Low Emissions development Strategies (LEDs) and development and implementation of low-carbon, resilient programs which are adequate to the local needs. A

Measurement, Reporting and Verification framework of local climate action is also addressed, by using globally-recognized methodologies for consistency, comparison and aggregation across different entities and initiatives. Transparent reporting of local climate data is essential to ensure the credibility and empowerment of local governments as partners in the global climate regime.

As a conclusion from the multiple initiatives analyzed, collaborative engagement emerges as an enabler for the sharing of best practices, vertical-integration of policies and investment plans across multi-levels of government, mainstreaming low-carbon strategies into all sectors of urban planning and development, and fast-tracking climate action.

("ICLEI – Local Governments for Sustainability is an international association of Local Governments which has more than 1000 members in 86 countries.")

O-4415b-04

Sustainability governance: the role of entrepreneurs in triggering transformative development pathway shifts
S. Burch (1)

(1) University of Waterloo, Geography and Environmental Management, Waterloo, Ontario, Canada

Sustainability transitions are fluid and multi-faceted phenomena, and may be characterized by multiple fast-change starts, punctuated equilibria, ‘false starts,’ punctuated equilibria, and change. These transitions are taking place at very small, community-based scales, and are driven by grassroots or bottom-up initiatives. While the idiosyncrasies of a particular urban context may strain our capacity to garner lessons that apply to other cities, social learning is a crucial dimension of accelerated sustainability transitions. In particular, cases of established leadership and innovative responses to sustainability challenges provide important insights into the roots, enabling factors, and various pathways that sustainability transitions might follow.

Despite increasingly frequent engagement with large corporate partners, cities rarely have the capacity to meaningfully engage with the abundant variety of small businesses that contribute much of the innovation necessary for a transition to low carbon, resilient communities. These entrepreneurs are often characterized by their flexibility and rapid adaptation, the opportunities that others might view as risks, and create the ‘radical novelties’ that are central to sustainability transitions. In this talk, I explore the role that entrepreneurs in general, but small businesses in particular, can play in sustainability transitions. I investigate novel mechanisms that are emerging that might contribute to more effective governance of this group of non-state actors, and the potential that a multi-level governance approach might have to accelerate innovation.

4415 - POSTER PRESENTATIONS

P-4415-01

Mitigating Climate Change Through Managing Urban Mobility and Urban Form
R. Agustina (1)

(1) National Institute of Technology (Itenas), Urban and Regional Planning, Bandung, West Java, Indonesia

Some researches have emphasized that travel patterns and their impacts on the environment are strongly related to the urban form. It is also believed that the private automobile has been the primary cause of the expansion of cities. However, in fact, they affect each other. The urban form affects the travel pattern, and the travel pattern affects the cause of the changes in the socio-economic context of urban life that are also responsible for the growth in car ownership.

The high-energy consumption of transport in low-density cities has become a matter of growing concern. The threat of long-term climate changes due to greenhouse gases have sharpened the awareness that present energy prices
Integration of adaptation to climate change within the design process of urban planning projects: new tool(s) and new methodology(ies)

M. Colombert (1); M. Gantois, (2); L. Jacquet, (3); A. Lesueur, (4); G. Meunier, (5); H. Nassopoulos, (1); J.L. Salagnac, (5); J. Glowacki (1);
(1) Ecole des Hautes Études en Sciences Sociales, Paris, France; (2) City of Paris, Paris, France; (3) EGIS Concept / ELIOTH, Montreuil, France; (4) CDC Climat, Paris, France; (5) CSTB, Desh, Champs-sur-Marne, France

During the ADAPTATIO project, partners have reflected on the means available to address in the design of development projects the issue of adaptation to climate change. The Climate Change Committee for this project has been defined in terms of two key resources for tomorrow: water and energy. It tries to explain to what extent the urban form affects the travel pattern. It tries to explore how it is strongly related to the environment especially through the air pollution factor.

This paper discovers the impacts of the urban form on the travel pattern. It tries to explain to what extent the urban form affects the travel pattern and how it is strongly related to the environment especially through the air pollution factor.

Adaptation and resilience are emerging as key components to the paradigm shift that it is required as a result of the wicked problems of climate change and resource depletion that characterize the urban reality of the early XXIst century. The lack of emphasis on the examination of governance from a practical perspective is stunting the transfer of academic ideas to actual interventions and hindering the timely implementation of solutions. This paper addresses these issues by analyzing the newly released Living Community Challenge (LCC) certification system as a conceptual framework in guiding interventions for adaptation and resilience in cities.

The presentation will be separated into four sections: 1-characterization of principal parameters in resilience and adaptation, 2-synthesis of currently applied methodologies, 3-identification of recognized barriers and adaptation, and 4-analysis of the LCC certification system as a regulatory tool. Specifically, in the first section, I will be performing an epistemological analysis of the fundamental concepts of climate change adaptation within the context of urban planning processes. Second, I will provide a summary of current methodologies used in adaptation experiments, as well as juxtaposing these methodologies against theoretical and practical solutions proposed by many leading thinkers in the field of adaptation planning. I will discuss the involvement of these processes in strategic program development, especially as pertaining to the importance of the multi-level governance frameworks and the transmission of information in institutional learning. The use of innovative ideas such as experimentation, market-based approaches and maintenance management will be addressed, as well as the examination of the obstacles encountered in applying climate change sensitive modifications to regulatory assessment in cities and the overcoming of the prevailing barriers accompanying legitimacy/power struggles and the characteristics of policy development coupled with super wicked problems.

Finally, the LCC certification system will be juxtaposed against the theoretical groundwork identified in the first three sections to establish connections between these processes and demonstrate the potential for real-life application in order to meet adaptation and resilience goals. The presentation will answer the following questions: Does the LCC certification model adaptation and resilience goals and strategies? How is it implemented? How does the certification system measure against current methodologies applied in existing experimentation? Does the tool provide a structure which enables well-recognized barriers to be surmounted more easily or does it create potential negative feedbacks hampering its use?
As the urgency for climate change adaptation in cities increases, the need for tools which can guide practitioners in uncharted waters will become pressing. This analysis of the Living Community Challenge (LCC) examines the system within the framework of academic theory on adaptation. In order to facilitate community approaches to sustainability and resilience.

P-4415-04
Livable Urban Futures - Process and Way Forward for Urban within Future Earth
C. Griffith (1); P. Romero Lankao (2); D. Simon (3)
(1) UGEC Project, ASU GIOS, Tempe, United States of America; (2) University of Colorado, Boulder, United States of America; (3) Chalmers University of Technology, Mistra urban futures, Gothenburg, Sweden

The complexity of urban systems and the global sustainability challenges that we face require inter- and transdisciplinary research that combines context sensitive regional and global approaches to inform and challenge solutions. Although traditions of addressing urban complexities have long existed in the social sciences, humanities, engineering, and natural sciences, we have barely scratched the surface in our efforts to understand meeting our global challenges. A variety of interdisciplinary and co-produced research on the interactions and feedbacks between urbanization, urban areas and global environmental change (GEC) profoundly limits the potential to intentionally shift development pathways through planned governmental and nongovernmental actions.

Sponsored by the Science and Technology Alliance for Global Sustainability, the global research platform Future Earth represents a new opportunity to rethink how GEC research is organized to encourage interdisciplinarity, and how it can better connect science with policy in order to offer solutions to today’s grand sustainability challenges. Future Earth recently published its 2014 Strategic Research Agenda naming ‘urban’ as one of its priority research areas. With this changing global research landscape, a number of urban research and practice communities are currently interested in new opportunities for enriched collaboration and for expanding and enhancing the ‘urban’ research agenda under the Future Earth framework. There is a lot of fertile ground for innovative research to promote linkages across established or rapidly emerging areas of urban and environmental research and the Future Earth research themes.

In February 2014 and March 2015, Scoping Meetings were held in London, UK and Boulder, CO, USA that brought together representatives of different regions, disciplinary backgrounds, and organizations to begin conversations on the gaps and future needs for urban research as well as the necessary components for the design of a new urban interdisciplinary initiative.

The purpose of this presentation is to share the outcomes of the two workshops and the overall process that has been set in motion by the Urbanization and Global Environmental Change (UGEC) Project along with many other partners known as the Future Earth Urban Platform (FEUP) Working Group. This Working Group is leading national and international governmental and nongovernmental actions.

P-4415-05
Qualitative Scenario Building for Post-carbon Cities
K. Johnson (1); M. Breil, (1); A. Bigano (2); C. Cattaneo (3)
(1) FEEM, Climate change and sustainable development, Venice, Italy; (2) FEEM, Climate change and sustainable development, energy resources and markets, Milan, Italy; (3) FEEM, Climate change and sustainable development, Milan, Italy

This contribution presents the results from interactions with representatives in 10 cities of different sizes, located across Europe at the development of local visions and scenarios for transitioning to become post-carbon by 2050. Findings are based on experiences from the European Union funded project Post-Carbon Cities of Tomorrow (POCACT) development of an evidence-based roadmap for post-carbon European cities in 2050.

By means of holding local workshops in a participatory case study approach, the foresight exercise is conducted using a two-step methodology, consisting of vision building and back casting exercises. Both exercises have a strong focus on the participation of stakeholders. The use of a participatory approach, where the people whose futures are being discussed are the key actors of the process, can improve the relevance and hence usefulness of scenarios. Creative brainstorming is employed to induce stakeholders to first envision the future of their city, and then develop qualitative scenarios describing how the transition to reach their post-carbon vision might be possible. Obstacles and opportunities that might be encountered along the way are identified, and actions needed to meet future goals are highlighted. The case study cities include Barcelona, Copenhagen/Malmö, Istanbul, Lisbon, Ljubljana, Milan/Turin, Rostock, and Zagreb.

Initial results from 6 out of 10 case study cities show similar elements in the local strategies that have been proposed by local stakeholders, focusing primarily on urban projects for energy efficiency and the transition to non-fossil energy resource models. The specific mix of strategies envisaged in these fields for each city depends both on different points of departure with regards to local governance (greater or smaller financial autonomy, extension of the municipal jurisdiction, etc.), and in part on specific local factors (greater or smaller financial autonomy, extension of the municipal jurisdiction, etc.).

The complexity of urban systems and the global sustainability challenges that we face require inter- and transdisciplinary research that combines context sensitive regional and global approaches to inform and challenge solutions. Although traditions of addressing urban complexities have long existed in the social sciences, humanities, engineering, and natural sciences, we have barely scratched the surface in our efforts to understand meeting our global challenges. A variety of interdisciplinary and co-produced research on the interactions and feedbacks between urbanization, urban areas and global environmental change (GEC) profoundly limits the potential to intentionally shift development pathways through planned governmental and nongovernmental actions.

Sponsored by the Science and Technology Alliance for Global Sustainability, the global research platform Future Earth represents a new opportunity to rethink how GEC research is organized to encourage interdisciplinarity, and how it can better connect science with policy in order to offer solutions to today’s grand sustainability challenges. Future Earth recently published its 2014 Strategic Research Agenda naming ‘urban’ as one of its priority research areas. With this changing global research landscape, a number of urban research and practice communities are currently interested in new opportunities for enriched collaboration and for expanding and enhancing the ‘urban’ research agenda under the Future Earth framework. There is a lot of fertile ground for innovative research to promote linkages across established or rapidly emerging areas of urban and environmental research and the Future Earth research themes.

In February 2014 and March 2015, Scoping Meetings were held in London, UK and Boulder, CO, USA that brought together representatives of different regions, disciplinary backgrounds, and organizations to begin conversations on the gaps and future needs for urban research as well as the necessary components for the design of a new urban interdisciplinary initiative.

The purpose of this presentation is to share the outcomes of the two workshops and the overall process that has been set in motion by the Urbanization and Global Environmental Change (UGEC) Project along with many other partners known as the Future Earth Urban Platform (FEUP) Working Group. This Working Group is leading national and international governmental and nongovernmental actions.

P-4415-06
Reimagining Civic Technologies for the Urban Poor in Indian Cities
S. Kesavan (1); S. Kairum, (1)
(1) Crosslinks Foundation, Bangalore, Karnataka, India

Introduction: People-centred economic transformation will play an important role in realizing inclusive and sustainable development in an increasingly urbanizing world, UN member states have therefore accorded a central place to ‘urban’ which is 33% of the world’s population and living in slums. Urbanization in India, like in other low and middle-income developing countries, has been characterized by...
Adapting cities to climate change: a systemic modelling approach

V. Masson (1) ; A. Lemonsu (1) ; C. Marchadier (1) ; M. Bonnefond (2) ; Hidalgó (4) ; T. Tang (2) ; N. Long (6) ; MP. Moine (7) ; C. Demunck (1) ; G. Pigeon (1) ; JL. Salagnac (8) ; V. Viguie (9) ; K. Zibouche (10) ; L. Nolagues (11) ; S. Hallegatte (12)

(1) CNRS/Météo-France, Toulouse, France; (2) ENSA, Toulouse, France; (3) AUAT, Toulouse, France; (4) LISSAT, Toulouse, France; (5) GEOE, Toulouse, France; (6) LIENs, La Rochelle, France; (7) CERFACS, Toulouse, France; (8) CSTB, Desh, Champs-sur-Marne, France; (9) CIRED, Ecole des arts et métiers ParisTech, Paris, France; (10) CSTB, Paris, France; (11) IAU Ile de France, Paris, France; (12) The World Bank (WB), Washington, United States of America

To answer the climate change challenge, all states have to reduce their greenhouse gas emissions, but also to adopt adaptation measures to limit the negative impacts of global warming on the population, the economy and the environment. The question arises especially for cities.

Because of complex interactions between climate change, the evolution of cities and its inhabitants, studying adaptation strategies for cities requires a strong interdisciplinary approach involving urban planners, building engineers, and researchers in architecture, meteorology, climate, economy, and social sciences.

Our four-step methodology consists firstly of defining interdisciplinary scenarios at several scales influencing the city evolution; secondly of simulating long term city evolution based on socio-economic and land-use models; thirdly of calculating impacts with physical models, and finally of calculating the potential of identifying the impacts and evaluating the adaptation strategies.

Interdisciplinary systemic modelling performs well to evaluate several adaptation strategies for a very broad range of topics. Some of the results obtained for the agglomerations of Paris through our interdisciplinary research projects VURCA and MUSCADE will be discussed.

A finding is that urban planning strategies may have unexpected influence on city expansion when considered on the very long term of the climate change. Another is that the combine effect of global warming and UHI can lead in the future to larger energy consumption in summer than in winter.

Indeed, air-conditioning will probably be necessary in 2100, because of expected stronger, and longer, heat waves. Limiting the UHI intensity allows for energy savings, and hence contributes to climate change mitigation. Adaptation strategies exist to limit air-conditioning use, both in time and intensity.

Analysis of several vegetation strategies, at several spatial and planning scales (from agricultural practices in the city surroundings to urban trees and green-roofs) have been performed and evaluated. Based on these, strategies have been put in place to reduce the UHI. Finally, inhabitants’ use and practices seem to be an efficient lever to reduce energy consumption in buildings and its impact on the urban climate.

P-4415-08

How do we Create and Build Knowledge Partnerships for Cities?: The Urban Climate Change Research Network (UCCRN) ARC3-2

C. Rosenzweig (1) ; S. Ali Ibrahim (2)

(1) NASA Goddard Institute for Space Studies, New York, United States of America; (2) Urban Climate Change Research Network (UCCRN), Columbia University, New York, United States of America

The objective of this presentation is to introduce the Urban Climate Change Research Network (UCCRN), and to foster a dialogue between global experts and local policy leaders regarding latest scientific findings and action areas on cities and climate change.

Climate change mitigation and adaptation are areas of high priority action in the urban context. These are often dealt with as separate issues in academic research, international climate talks, as well as national and local policy-making — leading to a situation where these focus areas often compete for funding and for decision-makers’ attention. The session will discuss the main challenges and potential of cities to integrate climate change adaptation and mitigation actions.

This presentation will introduce the UCCRN and present initial findings from the Second UCCRN Assessment Report on Climate Change and Cities (ARC3-2), concerning interrelationships between adaptation and mitigation in cities. Synergies, conflicts and trade-offs between adaptation and mitigation will be analyzed and discussed across scales. The session will illustrate the need and importance of building a robust climate knowledge base in cities to support them in developing climate change adaptation strategies to address both climate adaptation and mitigation in an integrated manner.

The objective of the UCCRN is to bring together experts
working on global-scale, climate change and cities assessments in order to simultaneously present state-of-the-art knowledge on how cities are responding to climate change and to define emerging opportunities and challenges to the effective placement of this knowledge in the hands of local stakeholders and decision-makers.

The First UCCRN Assessment Report on Climate Change and Cities (ARC3) was published in 2011 by Cambridge University Press, and articulates urban climate risk frameworks, climate science for cities, and derives policy implications for key urban sectors — water and sanitation, energy, transportation, public health -- and cross-cutting issues through land use and governance. The ARC3 report, containing 46 city adaptation and mitigation case studies, represents a four-year effort by 100+ scholars from over 50 cities in both developing and developed countries, and is one of the first global, cross-disciplinary, cross-sector, science-based assessment to address climate risks, adaptation, mitigation, and policy mechanisms relevant to cities.

The UCCRN is now working towards launching the next installment in this ongoing series, the Second UCCRN Assessment Report on Climate Change and Cities (ARC3–2). This session will present a ‘First Look’ at the ARC3–2 Report, which has been submitted to Cambridge University Press. The ARC3–2 Report is scheduled to be launched at COP21 in Paris.

The content and format of the ARC3–2 report has been based on several scoping session dialogues held at international conferences, inviting thoughts and reflections from urban and climate change scholars, city practitioners, and stakeholders. It has also taken into account survey feedback from ARC3 users and city officials. This discussion will highlight UCCRN’s approach to knowledge creation and the status and next steps for ARC3–2.

The presentation will comprise of an introduction by the Co-Editors of the ARC3–2, its new topics and novel perspectives. It will present the main thrust of the Report and the analytical challenges of the main sections of ARC3–2, and will outline the content, analytical breath and anticipated challenges in building the main sections of the report, including: Interdisciplinary methods and tools to analyze cross-cutting processes driving climate change and sustainable development; climate science and disaster risk management; urban infrastructure; urban ecosystems; and governance, policy and finance. It will also include details on the UCCRN Regional Hubs in Paris, Rio, and Durban, to be launched at COP21. Through multi-dimensional participation, the audience will be able to grasp key regional priorities addressed in ARC3–2, with concrete examples of relevant analytical and policy cases. It will also discuss innovations for analyzing, reporting and communicating scientific progress in this field. This includes a short briefing on how ARC3–2 is building a storing communication platform (i.e. a Case Study Docking Station) to improve access to information by policy makers, academics and practitioners.


J. Taminiau (1); J. Byrne, (1)
(1) University of Delaware, Center for Energy and Environmental Policy, Newark, Delaware, United States of America

A significant and sustained transition to a renewable energy future required to avoid further climate change continues to elude societies. Meanwhile, cities play an increasingly important role as they have propelled themselves onto the global climate change stage and have engaged in polycentric networks. To achieve substantial energy transformation while capturing the dynamic and important role reserved for the world’s cities, this article reconsideres finance-policymarket interactions by positioning the build-out of a particular renewable energy technology, photovoltaic (PV) energy, as a commitment to infrastructure-scale development. The concept of the so-called ‘solar city’ [1] is analyzed where large-scale deployment of urban PV essentially transforms the urban fabric into an urban renewable energy power plant as the strategy utilizes the vast rooftop real estate available in all cities. More specifically, a capital market strategy to finance the infrastructure-scale implementation of urban PV is evaluated for six case study cities that have taken up active global roles – Amsterdam, London, Munich, New York City, Seoul, and Tokyo. The paper makes clear the substantial potential of the solar city concept in each location and outlines a practical financing strategy to realize the potential.


Social Transformations towards Sustainability – needs and opportunities for transformative, transdisciplinary science

H. Hackmann (1)
(1) International Council for Science (ICSU), Paris, France

Research on global environmental change and sustainability increasingly goes hand-in-hand with calls for deep social change, and yet we know very little about how real and enduring social transformation comes about and how – if at all – it can or should be initiated, fostered or steered. ‘Transformations towards Sustainability’ is one of the three major thematic lines of activity of Future Earth, the new international hub coordinating research on global environmental change and sustainability, along with ‘Dynamic Planet’ and ‘Global Sustainable Development’. As a direct contribution to this initiative, the International Social Science Council recently launched a research programme on Transformations to Sustainability in the first significant global effort to address knowledge gaps around social transformation.
Stakeholder based science in transition research – challenges and opportunities

I. Mielke (1) ; H. Vermaßen (2) ; S. Ellenbeck (3) ; B. Fernandez Milan (4)

(1) Global Climate Forum (GCF), Green Growth, Berlin, Germany; (2) Center for Political Practices and Orders, University of Erfurt, Erfurt, Germany; (3) Potsdam Institute for Climate Impact Research, Potsdam, Germany; (4) Mercator Research Institute on Global Commons and Climate Change, Berlin, Berlin, Germany

The clean energy transition – based on the findings of the IPCC and others – is a highly political issue. It touches the way how and especially the economy is organized, but also requires change on a personal and community level. Powerful interests of all status quo advocates are at stake and there exists not at all a consensus on how to transform and where to transform to. Hence, research on possible decarbonization pathways is a tricky issue that led researchers to involve stakeholders more strongly in the scientific process. Reasons behind this are (at least) twofold: First, engaging stakeholders more actively can facilitate access to issue-specific insider information that helps tackle scientific uncertainty and consequently improve the research process. Second, such involvement is perceived as contributing to common good which could increase the influence of research on decision-making in political and economic arenas. However, these developments challenge the classical way scientific research is carried out and raise the question of “objectiveness” and value- and interest-driven research results.

We use the case of clean energy transition in Germany and Europe to systematize and discuss arguments for and against stakeholder based science and put them in a meta-scientific context. By doing so, we tackle the following questions: What kind of knowledge can be generated if stakeholders dialogue involving actors with varying degrees of influence in society and how can it be used? Which are the limitations of the so-called co-production of knowledge? How can researchers coordinate and evaluate the activities of all stakeholders involved in the research process? What kind of trade-offs exist in the way research involves stakeholders and what implications do different approaches have for the science-policy interface? Our discussion paper thus investigates the influence of stakeholder based science on research “validity” and “objectivity”, and its effects on research processes.

Transforming Science to meet Society’s Needs - The Social Footprint Laboratory

D. McBain (1); M. Joy (1)

(1) University of Sydney, Integrated Sustainability Analysis, Sydney, Australia

A quiet revolution is taking place that began a decade ago on a small Pacific island. A group of trans disciplinary academics had gathered to enjoy the sun, great company and discuss the how they could share data in a way that would be scalable and replicable. The data would be based on the trade in the world economy, and have detailed sets of environmental accounts for countries globally. When these data sets were all used together, the impact could be transformational. Complex global problems, such as underpaying social footprints and the consequences of how things are modeled and scenario tested. Academics from across the world could contribute and upload environmental and economic data, to be used with a multi-regional input-output database. The Friendly Interactive User interface has now been uploaded to a cloud based platform. In 2014 this idyll dream came to fruition in the form of the Australian Industrial Ecology Virtual Laboratory (IELab). The IELab – the transformational in bringing together academics, early career researchers, and users to better understand the environmental impacts of consumption, production and trade.

Now that the lessons have been learned for environmental data using economic modelling, researchers are developing the Social Footprint Laboratory (SFL). Where the IELab can be used to model carbon, energy and water footprints, the SFL will model social footprints such as labour or inequality. Social footprints are already being used to demonstrate the inequality in trade between countries, and the relationships between producing and consuming nations, and the embedded social impacts such as accidents and even workplace deaths associated with production. The development of relevant indicators in the SFL will provide a focus on basic needs and the capacity to engage local stakeholders to define and model relevant indicators for transformational change for social sustainability, as well as develop networks for data collection, sharing and use. The power and innovation of the project is to enhance and extend the existing economic and environmental data and structures of the IELab, with the critical social data and indicators required to identify, guide and monitor changes towards sustainability.

The development of these cloud based tools will bring together users such as governments, businesses, non-government organisations (NGO’s), academic research institutions and international institutions worldwide to start to understand the drivers of globally and locally complex problems such as climate change, income, poverty and child labour have already been used through demonstration to the different user groups of how the data in the SFL can be applied.

Existing data sets on social indicators such as employment, income, poverty and child labour have already been used with the multi-regional input-output databases, in both the IELab and the Social Hotspots Database, providing evidence to the different user groups of how the data in the SFL can be applied.

This paper will present the transformational work on the IELab, giving examples of studies this work has enabled early career researchers to conduct and publish and share practical experiences of building a virtual laboratory in Australia and scaling it to a global capacity. It will also outline the proposed SFL project and network as part of the Social Footprint Laboratory (SFL). The project will demonstrate and showcase some of the social footprinting studies conducted to date and how this multidisciplinary work can contribute to solutions oriented research on climate change.
agroforestry; facilitating increased access to traditional foods, particularly in Indigenous communities; developing appropriate alternative markets for ecological products; and, implementing participatory governance systems, for example for organic certification.

By analyzing and developing connectivity amongst projects such as these, our transdisciplinary network of scholars and practitioners aims to increase the scope of their transformative potential. Specifically, our objectives are to: 1) Use a social economy of food as a lever to explore socially just, economically robust, and ecologically regenerative sustainable opportunities for communities in poor rural areas. This will help increase their ability to address the interrelated challenges of climate change, poverty, and food insecurity; 2) Build direct person-to-person (or community-to-community) knowledge flows that enable citizens in the Global South to understand the impacts of climate change, poverty, and food insecurity in communities of the Global South, and also build solidarity amongst communities in the Global South; 3) Create a networked learning community to facilitate the exchange of knowledge regarding concrete examples of innovative, community-scale solutions to the problems of climate change, poverty, and food insecurity; and 4) Use this knowledge-network as a platform to extend knowledge sharing to other communities. This learning community will highlight the need and creation of knowledge between South and North and between academic and community partners, and be facilitated in a way that empowers traditionally marginalized communities. It would also enhance the capacity of researchers/scientists – particularly emerging scholars – to analyze household and community-level adaptation strategies, and inform climate-smart policies.

The proposed paper will highlight some of the advances that have been made to date by FEAST network partners working at the regional scale to address climate change, poverty, and food insecurity, particularly for marginalized populations including women, youth, Indigenous communities, and smallholder farmers. It will also outline how the development of a robust transdisciplinary knowledge network creates opportunities to increase the transformative potential of existing regional work.

O-4417-04

Strengthening collaboration for transformation to sustainability in research and education at universities

P. Adam (1); H. Kromp-Kolb (1); T. Lindenthal (1)
(1) Centre for Global Change & Sustainability, University of Natural Resources and Life Sciences, Vienna, Austria

To be able to respond to grand societal challenges such as climate change, it is necessary for universities and other research organisations to recognise and act upon their responsibilities as both educators and generators of knowledge. An effective contribution of science to societal transformation requires an adaptation of teaching and research activities and intensified collaboration and networking. Equally important is that science opens up to civil society and improves interactions with decision makers. Inter- and trans-disciplinary approaches can help elucidate the reasons behind these challenges.

Innovations of low carbon energy services to off-grid communities. Of particular interest to this paper is the development of novel payment mechanisms for solar energy, utilising mobile phone technologies. Whilst innovation policies in China are clearly succeeding in the competitive production of low-cost PV panels, primarily for export, the uptake of PV in poor rural areas remains relatively slow. Participants identified the need to move away from technology-focused approaches to expanding energy access towards bottom-up approaches that also integrate concerns embodied in a new national government focus on poverty reduction, seen for example in the State Council’s new policies on rural participation.

The paper will focus in particular on the examples from China and Africa, which primarily address the challenge of low carbon transitions that serve the needs of the poor. In each case, local innovations were identified that related to solar photovoltaic technologies, and participants discussed the problem of enabling access among poorer communities.

O-4417-05

Networked co-design for trans-national sustainability-oriented innovation systems

A. Ely (1)
(1) STEPS Centre, SPRU – Science Policy Research Unit, Sussex, United Kingdom

This paper presents initial findings from a co-design process involving ‘transformation platforms’ in six different high, middle and low-income countries as part of the ‘Constructing Pathways to Sustainability’ network. In each case, co-design workshops were hosted in order to bring stakeholders together around challenges that linked to climate change, including sustainable cities, sustainable agricultural and food systems and low carbon energy. In all cases, the co-design process brought together scientists and knowledge partners in order to analyse the locally-defined problem and explore alternative pathways serving environmental sustainability and social justice objectives.

The paper will focus in particular on the examples from China and Africa, which primarily address the challenge of low carbon transitions that serve the needs of the poor. In each case, local innovations were identified that related to solar photovoltaic technologies, and participants discussed the problem of enabling access among poorer communities. Whilst innovation policies in China are clearly succeeding in the competitive production of low-cost PV panels, primarily for export, the uptake of PV in poor rural areas remains relatively slow. Participants identified the need to move away from technology-focused approaches to expanding energy access towards bottom-up approaches that also integrate concerns embodied in a new national government focus on poverty reduction, seen for example in the State Council’s new policies on rural participation.

In the African case, participants discussed the utility of solar home systems (SHSs) and biomass in providing energy services to off-grid communities. Of particular interest to this paper is the development of novel payment mechanisms for solar energy, utilising mobile phone technologies, that have been implemented in the case studies. These are being recombined with solar PV hardware imported from China to produce a (socio-technical) system with potential to enable low carbon transitions that serve the needs of the poor.

The networked approach to co-design enabled the pairing of the China and Africa cases, offering opportunities to explore linkages and mutual learning across continents.
Collaborative political ecology: Mapping movements to leave oil in the soil with and for Environmental Justice Organizations

L. Temper (1)
(1) Institute of Environmental Sciences and Technology (ICTA)- Autonomous University of Barcelona, Barcelona, Spain

This paper presents the results of the collaborative work on climate justice undertaken in the EJOLT (Environmental Justice Organizations Liabilities and Trade) EU FP7 project through the presentation and analysis of over 300 cases of conflicts over fossil fuel extraction and infrastructure as documented in the Atlas of Environmental Justice (www.ejatlas.org).

The Global Atlas of Environmental Justice (www.ejatlas.org) is a collaborative project that draws on activist knowledge to document social conflict over the environment. Ecological conflicts are defined as “mobilizations by local communities, social movements and EJOs against particular economic activities (or state policies), in which concerns about current or future negative environmental impacts are an important part of the grievances, along with social, psychological and political impacts.”

The Global Atlas of Environmental Justice currently documents over 1400 such ecological conflicts displayed on an online interactive map. Each conflict contains around 100 fields including activity type and commodity, actors, quantitative data, degree of violence, forms of action, outcomes and perception of success, among others. Over 250,000 users have opened over 1 million pages of the atlas in the last year since it has been public.

The atlas one hand serves to document, making visible, and support the struggle for environmental justice (EJ), with the ultimate goal of empowering movements and activists, and increasing the recognition and legitimacy of research done by environmental justice organizations. It also serves as an important activist resource for information sharing and networking.

Scientifically it contributes to a form of ‘statistical political ecology’, and the development of a system whereby a large number of ecological conflicts can be described, analyzed, and compared across geographies and thematic issues and across spatial and temporal scales. The global nature of the atlas enhances the study of transnational spatial patterns of environmental and economic risks and impacts and their connections through commodity and financial flows that cannot be gained except at broader geographic and political scales.

The EJatlas is part of a new wave of initiatives that use geo-spatial information and new spatial media to advance, legitimate and secure political claims (Elwood and Leszczynski 2012). Through these tools, individuals and institutions leverage digital spatial data and spatial technologies in negotiating social, political, and economic processes. The process of co-production of knowledge found in the EJatlas is thus a contribution to transcending the expert/amateur or expert/grassroot activist dichotomy, while creating a new spatial knowledge politics and contributing to a collaborative political ecology.

After an explanation of the methodology of the EJatlas process the paper will present results from a comparative survey of over 300 + cases related to climate justice and fossil fuel extraction in the EJatlas with an emphasis on the following lines of enquiry: 1) The increasingly interlinked nature of place-based mobilizations over fossil fuel extraction and their articulation with global climate activist movements 2) The growth in conflicts over new technologies such as hydraulic fracturing and how citizen science is created and knowledge diffused and transmitted between locations 3) The use of increasingly contentious and disruptive forms of resistance to fossil fuel expansion such as blockades in some regions 3) Transformative cases in the atlas that demonstrate how communities resisting fossil fuel extraction are presenting innovative governance mechanisms to leave oil in the soil and move towards energy sovereignty and post-extractivism.

The Role of Young Scientists in Advancing Knowledge and Informing Decisions in a Changing Climate

J. Baum (1)
(1) University of Victoria, Biology, Victoria, BC, Canada

Young scientists are passionate about addressing the climate challenge, and this community is increasingly being recognized for its leadership and contributions to international climate science and policy efforts. Processes such as the Intergovernmental Panel on Climate Change and the U.S. National Climate Assessment are making explicit efforts to include early-career scientists. Young scientists play critical roles in advancing the understanding of climate change, developing mitigation and adaptation solutions, and informing societal decisions that enhance sustainability in the face of climate change. Doing so often requires early-career researchers to work across traditional disciplinary boundaries throughout the process of discovery. In addition, many young scientists regularly engage with the public and with decision makers, such as resource managers, local officials, urban planners, and stakeholders, through their work. For such emerging leaders, metrics of professional success should therefore reflect not only new contributions to knowledge but also the tangible benefits that those insights bring to society. Despite progress in meaningfully integrating young scientists as leaders in the climate-science community, institutional barriers often hinder early-career researcher engagement both with the scientific community and with stakeholders. This talk will discuss opportunities and challenges facing young scientists working on transdisciplinary projects to inform sustainability solutions in a changing climate. In particular, organizations such as the Global Young Academy provide critical opportunities for mobilizing and empowering early-career scientists to become the leaders of tomorrow’s climate science and policy efforts.
**P-4417-02**

**“¿Post-normal research networks?: Rethinking the production of interdisciplinary and transectorial knowledge”**

MF. Fossa Riglos (1); V. Hernandez (2)
(1) Instituto de Altos Estudios Sociales/UNSAM—CONICET, Ciencias Sociales, San Martin, Buenos Aires, Argentina; (2) Instituto de ricerca per lo sviluppo, Paris, France

This presentation aims to reflect about the epistemological implications of knowledge production in the frame of international collaborative research networks on climate change and social impacts. The way in which knowledge is produced in the frame of international interdisciplinary networks and integrated into social action is a crucial process when a more effective response to the climate crisis is critical. The purpose of this paper is to present the Belmon Forum, an 11-year project started by researchers from the Observatory of Versailles-Saint-Quentin-en-Yvelines and the CEARC, (1) University of Versailles-Saint-Quentin-en-Yvelines, (2) University of Paris, France, to facilitate an understanding of how society and politics can work together to mitigate climate change. The project is based on the strong understanding that socially, culturally and scientifically, community centred goal is to apply innovative standardized transdisciplinary expertise that can contribute to the development of awareness and willingness into order to act in responsible ways.

**P-4417-03**

**Artistic: An Art and Science Integration Project to Enquire into Community Level Adaptation to Climate Change**

JP. Vanderlinden (1); J. Baztan (1)
(1) University of Versailles—Saint-Quentin en Yvelines, Observatory of versailles—saint-quentin-en-yvelines/cearc, Guyancourt, France

The purpose of this paper is to present the Belmon Forum «Adaptation Research a Transdisciplinary community and policy centered approach» (ARTistic) project. ARTistic’s goal is to apply innovative standardized transdisciplinary and interdisciplinary dynamics for climate change adaptation, in a socially, culturally and scientifically, community centred adaptation to climate change. The approach used in the project is based on the strong understanding that adaptation is: (a) still a concept of uncertain form; (b) a concept dealing with uncertainty; (c) a concept that calls for an analysis that goes beyond the traditional disciplinary organization of science, and; (d) an unconventional process in the realm of science and policy integration.

The project is centered on case studies in France, Greenland, Russia, India, Canada, Alaska, and Senegal. In every site we jointly develop artwork while we analyze how natural science, essentially climate change sciences can be used in order to better adapt in the future, how society adapt to current changes and how memories of past adaptations frames current and future processes. Artforms are mobilized in order to share scientific results with local communities and policy makers, this in a way that respects cultural specificities while empowering stakeholders. ARTISTIC translates these "real life experiments" into stories and performances that are meaningful to those affected by climate change.

This project involves scientists from natural sciences, the social sciences and the humanities, as well as artists from the performing arts (playwrights, film directors) as well as visual arts (photographers, sculptors) working in France, Senegal, India, Russia, Greenland, Alaska, and Canada.

**P-4417-04**

**Science and art together**

C. Villegas Ivich (1)
(1) ArNaMe International, Paris, France

For decades worldwide scientists rely considerable efforts, to bring to the world and particularly to decision makers of the world, all the knowledge that has been obtained, while working together, they can create a new perception of the consequences of the causes of global warming, and its predictable and irreversible consequences on the environment and on the balance of the world. In other words, thanks to science, we have for a long time and especially today, sufficient data to take necessary decisions and measures. Despite this, greenhouse gas emissions have risen, and on the contrary, nothing has been done to effectively fight against global warming. It seems that we need new ways of thinking, of awareness, create responsibility and encourage ethical behavior in front of the current climate crisis. Would it be because conscience, responsibility and ethics are not forged with scientific reasoning? We think not. It is undoubtedly an urgent need to enrich and strengthen the contribution of science with other forms of perception and understanding of the world in order to go further in this thought. To understand and internalize what is at stake in environmental and climate issues, we should perhaps call upon our sensitivity and our emotional intelligence. This could probably help us to understand better what science tells us, because what we experience and understand don’t just have a rational explanation. This would bring us, among other things, to develop our empathy, to carry us to change the way we see and understand our relationship to life, to ourselves and to those other than us. This Other than Me is plural and singular, he surrounds us and expects from us another way to coexist and live on this planet. We must be able to pass to the other side of the mirror, to go beyond the immediacy of the climatic change, to understand what is our place and responsibility in the community of the livings. Among the possibilities that are available in order to succeed in this passage, the better of them is probably artistic. Indeed, it could best be along with science to bring us further in the process of evolution of our awareness, our understanding of reality and our way of being in the world process. The process of effective adaptation to climate change will be co-contracted between scientists and artists. The artistic work is then meant to help collaboration between science and art can happen. How, while working together, they can create a new perception and a new understanding of environmental and climate issues and in the end, how this alliance and this merger can contribute to the development of awareness and willingness into order to act in responsible ways.
Decision-relevant science for water security: An iterative process for targeting and evaluating impacts of watershed investments

AL. Vogl (1); J. Goldstein (2); R. Mcdonald (3); P. Hamel (4); M. Ruckelshaus (5)


Nature-based solutions are increasingly recognized as viable strategies to address many challenges for human development in areas such as water security, disaster risk mitigation, infrastructure development, and sustainable agriculture. Such strategies have the potential to provide adaptive solutions to changing climate conditions by encouraging ecosystem-based adaptive management and community participation. In the realm of water security, protecting and restoring nature to regulate the quantity and quality of water flows is increasingly viewed as a cost-effective and complementary strategy to engineered approaches. Broadly termed Investments in Watershed Services (IWS), these projects typically involve managing the conservation of source watersheds to secure clean water for downstream communities. Recent studies show the potential for IWS to provide a positive return-on-investment for water resources goals, to generate additional economic and social benefits, and to be a strategy that can adapt, potentially more so than engineered solutions, as climate conditions change. In 2013, there were an estimated 345 active IWS programs globally and an annual investment totaling $123.3 Billion (www.forest-trends.org/dir/sowi_2014/). Yet, despite its exponential growth over the past two decades, IWS remains a relatively small-scale, often one-off strategy in particular locations, which contrasts with the widespread use of engineered solutions.

We argue that a key barrier limiting the scope of IWS is that tools and guidance to bridge the science-to-practice gap are less well developed - tools to help practitioners understand if, where, and how well IWS will work. A recent plethora of reports and decision support tools highlight for cities, regional authorities, and corporate actors the risks that they face due to dependence on water resources (e.g., Ecolab and Trucost’s Water Risk Monetizer and Water Risk Filter). However, these tools largely focus on the “risk” component of the water security equation. To effectively mainstream IWS, decision makers need science that addresses the “opportunity” component of the equation - the degree to which improved watershed management activities can mitigate risk. Combining risk and opportunity information enables decision makers to quantify the scope for IWS and to identify actionable solutions that are specific to the decision context. Such decision support would allow policymakers to target natural capital investments towards programs (at global/ regional scales) or projects (at local scales) that promote IWS with the highest potential to be a cost-effective intervention. We will showcase several tools and methods developed by The Natural Capital Project – in collaboration with various NGO, academic and policy partners – in support of IWS programs in 7 countries across Latin America, India and Kenya. Our experiences illustrate the importance of co-producing ecosystem services information as part of an iterative research- application process, for 1) targeting investments based on ecosystem services outcomes, 2) addressing uncertainties around drivers of change (including climate change), and 3) monitoring and impact evaluation. Delivering more resource-efficient and transferable science will allow decision-makers to evaluate where IWS is, and critically is not, likely to be an effective and robust institutional mechanism to achieve water security goals in the face of climate change.

Personal adaptation: discussions, decisions and planning

L. Coulter (1)

(1) Griffith University, Urban Research Program, Nathan, Queensland, Australia

Decisions that will be effective to manage the impacts...
of climate change that are now unavoidable will need to account for ongoing instability in social, economic and environmental systems. Commonly examined barriers in accounting for progressive climate impacts include: disbelief in aspects of climate change processes; lack of understanding of the impacts; poor access to relevant and credible information; and a felt need for greater certainty. Professionals who exchange climate change knowledge in research, policy, and practice will have overcome many, if not most, of the barriers through training and experience. Barriers that affect even these professionals are personal reactions to envisioning the future such as: emotive responses; lack of facility in future thinking; and subjective assessments of perceived risks and capacity. This paper draws on interviews that inquire into personal adaptation discussions and planning by Canadians and Australians. Participants have professional expertise and regular high-level communications regarding climate change with colleagues and the public. The interviews and this paper focus on a different sphere: discussions by these same professionals with family and friends. Key improvements in interpersonal discussions of climate change adaptation decisions and planning identified in the research include the need to: connect concern for mitigation of climate change to adaptation to climate impacts; think beyond unpleasant possibilities and envision future life affected by climate change; and foster skills for greater cooperation in education and planning. Even among this highly educated group there was difficulty in imagining changes in society in the climate of the future, especially among those who do not tend to engage in future thinking or plan for the long term. This has implications for our understanding of individual factors in climate adaptation decision processes that may shape the responses of individuals over time. Further study with people from other nations, professions and culture groups would broaden understanding of personal factors in adaptation decision-making.

Synthesis centers: an essential tool in our complex, data-rich future

A. Specht (1); J. Baron (2); M. Winter (3); F. Bishop, (4); J. Boyd, (5); A. Campbell, (6); F. Davis, (7); D. Hawthorne, (5); C. Jonsson, (4); J. Kramer, (5); T. Meagher, (8); M. Palmer, (9); S. Sahlén, (10); T. Vinther, (11)

(1) School of Geography, Planning and Environmental Management, University of Queensland, St Lucia, Queensland, Australia; (2) John Wesley Powell Center for Analysis and Synthesis, Fort Collins, CO, United States of America; (3) United States Geological Survey, Reston, VA, United States of America; (4) VRIT, National Center for Ecological Analysis and Synthesis, University of California, Santa Barbara, California, United States of America; (5) DFG German Research Foundation, German centre for integrative biodiversity research, Leipzig, Germany; (6) National Institute for Mathematical and Biological Synthesis, University of Tennessee, Knoxville, Tennessee, United States of America; (7) National Center for Ecological Analysis and Synthesis Center, University of Maryland, Annapolis, Maryland, United States of America; (8) Research Institute for Environment and Livelihoods, Charles darwin university, Darwin, Northern Territory, Australia; (7) National Center for Ecological Analysis and Synthesis, University of California, Santa Barbara, California, United States of America; (8) Environmental Omics Synthesis Centre, University of st andrews, St Andrews, Scotland, United Kingdom; (9) Centre for the Synthesis and Analysis of Biological Data, University of Edinburgh, Edinburgh, United Kingdom; (10) Canadian Institute of Ecology and Evolution, University of regina, Regina, Saskatchewan, Canada; (1) University of North Carolina, Biology, Chapel Hill, United States of America.

Climate change presents a challenge to traditional scientific practices of disciplinary focus and the well-established research pathway. Understanding and responding to global climate change requires the integration of an abundance of information over many disciplinary fields and from many different organisations, with the added urgency of needing rapid answers and quick actions. Synthesis centers provide a unique environment for harnessing knowledge and expertise to catalyse discovery through cross-disciplinary working collaborations. Supported scientific synthesis—the integration of disparate theories, methods, and data across disciplines, professional sectors, and scales—has been proved to provide general, robust scientific explanations and evidence-based solutions across the social, economic and scientific realms. We contend that providing a synthesis intervention is a necessary, even mandatory, requirement for humanity to properly address critical climate change challenges.

More than a dozen synthesis centers now exist across Europe, North America, Asia and Australia. These centers bring discipline-specific groups together for blocks of time to stimulate cross-sectoral creative thinking and insight. The synthesis center approach is a vital tool to achieve collective action and transformative solutions. It offers something rare: participation based on a collective interest to deliver outcomes, and distraction-free, supported time and space for groups to totally immerse themselves in a question. A common tool provided by all synthesis centers is the technological support to analyse and synthesise diverse and disparate datasets.

Each synthesis center reflects the imperatives uppermost in its own country and has developed a unique approach and expertise relevant to its mandate. Some centers emphasise the earth sciences, some the application of mathematics to biology, some natural resource management, social science and science policy, some the dynamics of marine and terrestrial ecosystems, inter alia. Conservatively, the Centers together have been instrumental in bringing more than 25 singular disciplines together to work in unique trans-disciplinary combinations to address complex problems. The Centers have amassed large networks of people and provide the necessary infrastructure and skills to support them to collaborate. As a group, newly formed into an independent (temporary) synthesis consortium (www.synthesis-consortium.org), these centers provide a powerful tool across the whole range of disciplines and geographies needed for innovative solution–oriented thinking around the effects of climate change.

The ENACTS (Enhancing National Climate Services) initiative is an ambitious effort to simultaneously improve the availability, access and use of climate information by working directly with National Meteorological and Hydrological Services (NMHS). It enables the NMHS to provide enhanced services by overcoming the challenges of data quality, availability and access – while at the same time fostering stakeholder engagement and use. The new spatially and temporally complete ENACTS data products allow for characterization of the climate in a high resolution, and potentially offer a low-cost, high impact opportunity to support applications and research. ENACTS has so far been implemented in Ethiopia, Madagascar, Tanzania, Rwanda and The Gambia at national levels, and at regional level for the CILSS countries (West African Sahel).
Assessing climate change vulnerability of species: best practice guidelines for conservation practitioners

W. Foden (1); R. Akcakaya, (2); D. Bickford, (3); S. Butchart, (4); J. Carr, (5); A. Hoffmann, (6); D. Hole, (7); B. Huntley, (8); T. Martin, (9); M. Pacifici, (10); B. Scheffers, (11); S. Williams, (11); B. Young, (12); K. Kovacs, (13); C. Midgley, (14); P. Pearce-Kelly, (15); R. Corlett (16); R. Pearson, (17); M. Stanley-Price, (18); J. Watson, (19)

(1) Global Change and Sustainability Research Institute, University of the Witwatersrand, Johannesburg, South Africa; (2) Stony Brook University, New York, United States of America; (3) National University of Singapore, Singapore; Singapore; (4) BirdLife International, Cambridge, United Kingdom; (5) IUCN Global Species Programme, Cambridge, United Kingdom; (6) University of Melbourne, Melbourne, Australia; (7) Conservation International, Washington DC, United States of America; (8) University of Durham, Durham, United Kingdom; (9) CSIRO, Brisbane, Australia; (10) University of Rome, Rome, Italy; (11) James Cook University, Townsville, Australia; (12) NatureServe, San Jose, Costa Rica; (13) Norwegian Polar Institute, Tromso, Norway; (14) University of Stellenbosch, Stellenbosch, South Africa; (15) Zoological Society of London, London, United Kingdom; (16) Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences, Center for integrative conservation, Menglin, Yunnan, China; (17) University College London, London, United Kingdom; (18) Oxford University, Oxford, United Kingdom; (19) Wildlife Conservation Society, Brisbane, Australia

For effective climate change adaptation planning, conservation practitioners must consider how their areas and species of concern are likely to be impacted by climate change. They face a burgeoning scientific literature describing a wide variety of methods for assessing species’ vulnerability to climate change, each with its own strengths and limitations. Based on input from species’ conservation scientists and practitioners, conservation communities, along with broad literature review, the IUCN Species Survival Commission’s Climate Change Specialist Group has developed guidance for selecting and applying methods for assessing species’ vulnerability to climate change.

The best practice guidelines outline commonly used approaches for assessing species’ climate change vulnerability namely correlative, mechanistic, trait-based, and trait-based approaches. They guide users to clearly define the scope and objectives of their assessments, and to critically evaluate data, technical expertise, time and financial resources. With the aid of a decision framework, users match their objectives with appropriate methods, and then identify those for which they have sufficient resources. The guidelines also include sections on selection and appropriate use of climate and biological data, selecting temporal and spatial scales, and working with uncertainty, knowledge gaps and indirect climate change impacts. They present overarching principles, ideas for communicating assessment results, and a broad range of case studies demonstrating how the guidelines can be applied.

This presentation provides an overview of the new best practice guidelines for assessing species’ vulnerability to climate change and analyzes attendee steps for making sound and defensible decisions on method choice. Through the guidelines we hope to make climate change vulnerability assessment more accessible to the conservation practitioner community, thereby providing the best possible foundation for climate change adaptation planning.

The experience of the Brazilian Climate and Health Observatory

R. Grazia, (1) C. Barcellos, (2); D. Silva, (3); H. Barros, (4); and M. Williams, (5)

(1) Fundação Oswaldo Cruz, Instituto de Comunicação e Informação Científica e Tecnológica, Laboratório de informação em saúde, Rio de Janeiro, RJ, Brazil; (2) Fundação Oswaldo Cruz, Centro de Informação Científica e Tecnológica, Laboratório de informação em saúde, Rio de Janeiro, RJ, Brazil; (3) Fundação Oswaldo Cruz, Centro de Informações Científicas e Tecnológicas, Laboratório de informação em saúde, Rio de Janeiro, RJ, Brazil; (4) Fundação Oswaldo Cruz, Instituto de Comunicação e Informação Científica e Tecnológica, Laboratório de informação em saúde, Rio de Janeiro, Brazil; (5) Fundação Oswaldo Cruz, Instituto de Comunicação e Informação Científica e Tecnológica, Laboratório de informação em saúde, Rio de Janeiro, RJ, Brazil

Gathering and analyzing data on climate and health, as well as information on socioeconomic and environmental factors, is essential for planning actions to adapt to and mitigate climate change. In view of the complexity of the processes involving environmental, social and health outcomes and climate change and its effects on health, it is essential to bring together and analyze data in such a way as to provide society, government agencies and the media with information. This presentation provides an overview of the follow-up, a set of data on the dimensions of the climate, environment, population and health is required. The Brazilian Climate and Health Observatory project is bringing information on the Brazilian Health and data available through an internet page (www.climesauda.icct.fc.ufrj.br) where data from different origins can be accessed on a common platform. This technology is innovative in that it allows users to make consultations that simultaneously use distributed data, i.e. data generated and maintained by different institutions. The Information Technology and Communication Center of the National University of Rome, Italy; (11) James Cook University, Townsville, Australia; (12) NatureServe, San Jose, Costa Rica; (13) Norwegian Polar Institute, Tromso, Norway; (14) University of Stellenbosch, Stellenbosch, South Africa; (15) Zoological Society of London, London, United Kingdom; (16) Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences, Center for integrative conservation, Menglin, Yunnan, China; (17) University College London, London, United Kingdom; (18) Oxford University, Oxford, United Kingdom; (19) Wildlife Conservation Society, Brisbane, Australia

The best practice guidelines outline commonly used approaches for assessing species’ climate change vulnerability namely correlative, mechanistic, trait-based, and trait-based approaches. They guide users to clearly define the scope and objectives of their assessments, and to critically evaluate data, technical expertise, time and financial resources. With the aid of a decision framework, users match their objectives with appropriate methods, and then identify those for which they have sufficient resources. The guidelines also include sections on selection and appropriate use of climate and biological data, selecting temporal and spatial scales, and working with uncertainty, knowledge gaps and indirect climate change impacts. They present overarching principles, ideas for communicating assessment results, and a broad range of case studies demonstrating how the guidelines can be applied.

This presentation provides an overview of the new best practice guidelines for assessing species’ vulnerability to climate change and analyzes attendee steps for making sound and defensible decisions on method choice. Through the guidelines we hope to make climate change vulnerability assessment more accessible to the conservation practitioner community, thereby providing the best possible foundation for climate change adaptation planning.

The Brazilian Climate and Health Observatory project is gathering information on the Brazilian climate and health and data available through an internet page (www.climesauda.icct.fc.ufrj.br) where data from different origins can be accessed on a common platform. This technology is innovative in that it allows users to make consultations that simultaneously use distributed data, i.e. data generated and maintained by different institutions. The Information Technology and Communication Center of the National University of Rome, Italy; (11) James Cook University, Townsville, Australia; (12) NatureServe, San Jose, Costa Rica; (13) Norwegian Polar Institute, Tromso, Norway; (14) University of Stellenbosch, Stellenbosch, South Africa; (15) Zoological Society of London, London, United Kingdom; (16) Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences, Center for integrative conservation, Menglin, Yunnan, China; (17) University College London, London, United Kingdom; (18) Oxford University, Oxford, United Kingdom; (19) Wildlife Conservation Society, Brisbane, Australia

The best practice guidelines outline commonly used approaches for assessing species’ climate change vulnerability namely correlative, mechanistic, trait-based, and trait-based approaches. They guide users to clearly define the scope and objectives of their assessments, and to critically evaluate data, technical expertise, time and financial resources. With the aid of a decision framework, users match their objectives with appropriate methods, and then identify those for which they have sufficient resources. The guidelines also include sections on selection and appropriate use of climate and biological data, selecting temporal and spatial scales, and working with uncertainty, knowledge gaps and indirect climate change impacts. They present overarching principles, ideas for communicating assessment results, and a broad range of case studies demonstrating how the guidelines can be applied.

This presentation provides an overview of the new best practice guidelines for assessing species’ vulnerability to climate change and analyzes attendee steps for making sound and defensible decisions on method choice. Through the guidelines we hope to make climate change vulnerability assessment more accessible to the conservation practitioner community, thereby providing the best possible foundation for climate change adaptation planning.
The Global Island Database as a strategic asset for island biodiversity issues

C. Depraetere (1) ; AL Dahl (2) ; J. Hutton (3)
(1) IRD, UMR ESPACE/DEV, Montpellier, France; (2) International Environment Forum, Geneva, Switzerland; (3) World Conservation Monitoring Centre, Cambridge, United Kingdom

The Global Island Database (GID) targets the five thematic requirements for islands as identified by the Convention on Biological Diversity (CBD/UNEP), namely biodiversity, climate change, invasive species, pollution and sustainability. It aims to provide a geographical and environmental strategic tool to define priority in island biodiversity issues, including assessment and protection, at a global scale. As such, it does not replace regional, national or local GIS databases but it comes in synergy with them in a macrobiological perspective. GID aims to be a GIS networking platform for international collaboration, noticeably for the Global Islands Partnership (GLISPA).

Some pioneering works were initiated in the 90ies in the scope of providing global information on islands before GIS and the WEB became available [1] [2]. The initiative of making available an online version of GID was supported by GLISPA, the UNEP WCMC and the Italian Government during the CBD CoP9 2008 in Bonn. The first version of Global Island Database (GID) was officially announced at the UN Commission on Sustainable Development SIDS Special Day of celebrations on 10 May 2010 in New York. The further versions were updated at the initiative of the WCMC and includes specific tools for interactive functionalities to users, as for instance the GID validation tool [3]. It allows edition and validation of spatial and attribute information for any islands including those not referenced in GID. It is an example of on-line participative science whose purpose is to improve and update the spatial accuracy and associated information relating to islands or islets whatever the size.

The GID present version takes account of more than 180,000 islands including all the 116,103 islands greater than 0.06 km² from New-Guinea (783,408 km²) down to the islet of Gemini close to the shore of Elba (0.06 km²). Each island receives a specific international island coding (IIC) and refers to attributes on geographical names, location, planimetry, human occupations, climatology, and topography (Table 1).

This GIS asset is not only allows the visualisation of data relevant for islands but also provides added value through contextual information, data analyses and potential biodiversity indicators for the various stakeholders requiring homogenous information for comparison purposes and prioritizing funding and actions. It is one of the tools which is urgently required to get over the present «island gap» facing SIDS and countries with islands, as stated by macro ecologists: «We found that environmental characteristics were harder to determine for islands because they are not well represented in most global environmental data sets» [4]. It is also worth noting that the UN Under-Secretary General and UNEP Executive Director, Achim Steiner said: “High quality databases are crucial for addressing both the threats to biodiversity and economically important ecosystems. The importance of GID for island nations cannot be over stated, and is long overdue” [5].

References:

Quantifying the changing shape of local climate

DA. Stainforth (1); S. Chapman, (2) ; N. Watkins, (3)
(1) London School of Economics, Grantham Research Institute, London, United Kingdom; (2) Centre for Fusion, Space and Astrophysics, Department of physics, Warwick, United Kingdom; (3) London School of Economics, Centre for the analysis of timeseries, London, United Kingdom

Climate is intrinsically a distribution and changing climate a change in distribution. Adaptation decisions and individual’s perceptions of climate change are influenced by changes in thresholds in these distributions. Different decisions are impacted by different thresholds but in most cases the relevant distributions are those experienced at local scales. To understand the impact of climate change on practical decisions requires us to quantify how local climatic distributions are changing shape. Such information also substantially affects how climate change can be communicated and made relevant.

Changes in the shape of local climatic distributions are influenced by global and large scale (sympatric) changes in the earth system but are mediated by local / meso-scale circumstances. It is not clear to what extent it is possible given current technology and model limitations, to predict such changes multiple decades in the future. However, it is becoming beginning to be possible to identify changes in the shape of local climate from observational timeseries in some locations. Such changes provide crucial information which can help decision makers optimise decisions for the lifetime of today by putting them in the context of the fine detail (geographic and distributional) information from recent decades. It also provides a baseline of climate change against which future projections can be put into context.

Here we will present such analyses showing the changing shape of European climatic distributions in terms of changing probabilities and changing decision-relevant thresholds. The process could be automated by climate services providers to generate output tailored to the needs and vulnerabilities of individuals and organisations. Challenges in the statistical interpretation of the data will be highlighted and a means of identifying robust aspects will be presented. Results will be shown from two recent papers which address local temperature distributions, and work-in-progress on changes in precipitation distributions. The analytical process can be seen as transforming direct weather observations into observations of climate change.

References:

Outlook for Integration between some African Countries (Egypt, Libya, Sudan and South Sudan as Case Study)

EHM. Ahmed (1)
(1) Lead Author, WG III, IPCC, climate change and sustainable development, Cairo, Egypt

Often considered by developed countries to developing countries as the countries lagging behind in everything, and deal with it as representing store of natural resources, which you can get from the developed countries to their raw materials cheaply and then send to the factories to...
return as producers full industrialization of the African market with densities high population to sell at very high prices, which has purchased raw materials.

In spite of the financial aid provided by the developed countries of the African countries are often consumed to feed those poor people and African countries remain waiting for food aid from rich countries, which give barely enough to eat.

In spite of the large number of economic programs and development provided by developed countries to developing countries and least developed countries, we did not get the results that seek to technology transfer, albeit a relative, so that they can African countries to adopt programs in the global financial aid to be highest possible, then the demand for agricultural production which is a variety of different countries can make a relative, but that demand has failed and call on the African parties and leaders of those countries free to study the reasons for the failure of the previous attempt and integration, and looking to the new leadership at these countries to try again and get rid of all the challenges and barriers to get success of the next attempt.

P-4418-02

Population Vulnerability and Adaptation to Climate Change in Large Metropolitan Areas: a Brazilian Perspective
A. Barbieri (1) ; G. Guedes (2)
(1) Universidade Federal de Minas Gerais (UFMG), Departamento de Demografia, Horizonte, Minas Gerais, Brazil; (2) Federal University of Minas Gerais, Department of Demography, Belo Horizonte, Minas Gerais, Brazil

The rapid urbanization process in Brazil and the consolidation of large metropolitan areas have created important challenges for public policies. This process has been accompanied by growing urbanization and urban growth have occurred without the corresponding investments in urban infrastructure and reduction of poverty and inequality. These problems assume a new momentum with the potential impacts of climate change in Brazil regarding, in particular, extreme rainy and dry seasons, health emergencies (such as dengue fever and respiratory diseases), urban disasters and water scarcity. The aim of this paper is to discuss a pilot research project and its corresponding conceptual and methodological framework to identify and assess population vulnerability to climate change in large Brazilian metropolitan areas. This pilot project is being developed as a key activity of the Rede Clima – the Brazilian Network for Research on Global Climate Changes from the Brazilian Ministry of Science, Technology, and Innovation. The main mission of Rede Clima is to generate and disseminate knowledge about the causes, effects, and adaptation mechanisms related to climate change in Brazil and consequently inform public policies. We will discuss the five focal areas in which we focus on: urban areas, three largest metropolitan areas of Brazil – São Paulo, Rio de Janeiro, and Belo Horizonte. The main methodological feature involves the use of a mixed methods evaluation (MME) approach to data collection on perceptions and attitudes of population towards potential climate impacts, as well as other primary and secondary data, which allow measuring intra-urban population vulnerability. This information will help us to assess profiles of population vulnerability at finer urban scales and develop alternative scenarios for adaptation policies in Brazil, as well as to improve tools for the dissemination of information and knowledge on adaptation to climate change to urban population and stakeholders. Finally, we will discuss how the research project will provide us a base for the creation of a monitoring system of the human dimensions of vulnerability and adaptation to climate change in the large Brazilian cities.

P-4418-03

Observatories for Climate Change Monitoring: Local vs Global Approaches
M. Fargette (1) ; M. Loireau (2) ; T. Libourel (3) ; N. Ben Katra (4)
(1) IRD, UMR Espace-Dev, Montpellier cedex 5, France; (2) IRD, Umr espace-dev, Montpellier, France; (3) Université Montpellier, Umr espace-dev, Montpellier, France; (4) Observatoire du Sahara et du Sahel, Tunis, Tunisia

Introduction: Eco–sociosystems are all impacted by Climate Change. The future of humanity depends upon the adequacy of analyses related to such systems. Several views prevail, some within a local approach, and others which take a more global view. These views are used in ascending or descending approaches. The aim of the article is to show a) how «local» and «global» are inseparable to prevent the both the state and the processes; b) how the two methods should be continuously confronted to each other. We capitalize on the conceptual expertise built during programmes aimed at the inventory of specific devices (scientific observatories for the acquisition and monitoring of socio-environmental phenomena).

System: Facing Climate Change, we will first assume a) that we consider the system emerging from «Earth-human interactions» (further on named System Earth) as an integrated (eco–socio)system, even though we are quite aware that some kind of systems would exist, regardless of climate change, while this may not be the case for mankind; b) that System Earth is a complex system, where natural and anthropogenic processes occur; c) that humanity (all of mankind) and sustainable future, at maintaining a relatively steady state (holocene like) for Earth System. As a system, System Earth has a structure with biophysical and human components and a functioning, the output of which may (partly or as a whole) be considered as adequate to social expectations. More generally, this may result in the concept of sustainable services. System Earth is a whole, consisting of elements, organized altogether in some more or less connected subsystems. Climate is one of these subsystems, which in turn consists of biophysical components. In addition, human interactions with this subsystem are key-points for studies and discussion. Therefore, and do anthropogenic processes interfere with the climate subsystem; the impacts of these interactions (in either ways) and relevant management measures for control and preservation both the stability of the system as a whole and human well-being, which take a more global view. These views prevail, some within a local approach and others which take a more global view. These views are used in ascending or descending approaches. The aim of the article is to show a) how «local» and «global» are inseparable to prevent the both the state and the processes; b) how the two methods should be continuously confronted to each other. We capitalize on the conceptual expertise built during programmes aimed at the inventory of specific devices (scientific observatories for the acquisition and monitoring of socio-environmental phenomena).

Observatory: For several years, we have built expertise on long-term ecosystem management, «Desertification» (ROSELT/OSS and REPSAHEL/OSS). This leads us to define the concept of «Scientific Observatory», which relies on a rigorous and scientific approach in order to observe the dynamics of systems. Because, even in science, work is often sectorial, the challenge in such observatories is to develop interdisciplinarity so that it becomes possible to share the best definition of theoretical models (of the observed system(s)) as well as methods for observation and analysis. If the observatory is to answer the question «How and to what extent do anthropogenic processes interfere with the climate subsystem?» The impacts of these interactions (in either ways) and relevant management measures for control and preservation both the stability of the system as a whole and human well-being, which take a more global view. These views prevail, some within a local approach and others which take a more global view. These views are used in ascending or descending approaches. The aim of the article is to show a) how «local» and «global» are inseparable to prevent the both the state and the processes; b) how the two methods should be continuously confronted to each other. We capitalize on the conceptual expertise built during programmes aimed at the inventory of specific devices (scientific observatories for the acquisition and monitoring of socio-environmental phenomena).

Montpellier, Umr espace-dev, Montpellier, France; (3) Université Montpellier, Umr espace-dev, Montpellier, France; (4) Observatoire du Sahara et du Sahel, Tunis, Tunisia

International Scientific Conference     7-10 JULY 2015    PARIS, FRANCE
ABSTRACT BOOK 751
to the given holistic ontology, with the global model. Such a network of observatories should be the tool of decision support for governance at both global and local scales.

Conclusion. Let’s stop trying to save the planet (it does not care) and save humanity instead. Our proposal makes a plea for the implementation of a network of perennial observatories; as a part of governance processes, this would provide a powerful support for decision making, both at a global and local scale.

**More than 20 computer prediction models are currently operated**

**P-4418-04**

**Vulnerability Sourcebook: Integrated and participatory vulnerability assessments support adaptation planning and evaluation**

C. Bollin (1)

(1) adelphi consult, climate adaptation, Berlin, Germany

Decision making on effective adaptation policies and actions depends on a sound assessment of adaptation needs and the identification of the most promising approaches. This requires information on types and extents of climate change impacts, existing vulnerability patterns, related adaptive capacities and already implemented measures. The assessment, in addition, has to be realized in a participatory manner in order to take into account all existing knowledge (technical, scientific, local experiences), allow common decision making on key factors and needs, and achieve the sensitization and political will that are later on needed for the planning, financing and implementation of adaptation activities.

A tool that has been explicitly put forward at international level for this purpose is the vulnerability assessments. Due to the variety of vulnerability definitions and methodologies to assess it, German International Cooperation GIZ commissioned the development of a standardized methodology and tools allowing a better comparability of results across sectors and regions. The Vulnerability Sourcebook, published in 2014, is a practical guideline that can be applied to support cross-sectoral, integrated and collaborative adaptation planning across different levels, especially in the context of the National Adaptation Plan processes (NAPs). Moreover, it is conceived for the Monitoring and Evaluation of adaptation as well.

The Vulnerability Sourcebook comprises eight modules and an annex that provide practical guidance on how to conduct standardized vulnerability assessments. Its application in Bolivia, Pakistan, Burundi and Mozambique demonstrated that it can make a valuable contribution to collaborative and integrated adaptation planning and the monitoring of adaptation. It combines outcome- and process-oriented perspectives and provides very detailed decision support.

The presentation will outline the tool itself and describe the results of the various application experiences, which concern national level as well as decentralized and community-based processes. The presentation will then stress the different results that have been used for concrete adaptation planning and implementation. These experiences serve also to discuss the different perspectives of various stakeholders and the demand-side aspects on decision support in climate adaptation.

**P-4418-05**

**Ethno-malacology in mangrove ecosystems: integrating local and scientific knowledge to assess socio-ecological variability and coastal change**

A. Burgos (1) ; M. Despinoy, (2) ; C. Sabinot, (2)


Ecosystems and societies face major emerging challenges as climate change and ecological services degradation. Nowadays, linking local and scientific knowledge through multi-scale assessments is at the heart of international debates. Although, ecological monitoring approaches to assess coastal change have improved considerably during the last decade, many projects still fail at incorporating local knowledge on the conception of the master plan and the analysis of the collected data. Participatory monitoring methods and assessments protocols of coastal change, especially relative to socio-ecological variability and actions for adaptation cannot be overlooked. There is a real need to develop an in-depth reflection on local knowledge and knowledge and methodologies to integrate them in the pool of data information for decision-making.

In the search for indicators to monitor and assess coastal change while combining local and scientific knowledge, mollusks appear to be particularly interesting for setting a constructive and interactive dialogue between scientists and local villagers. In the one hand, the cumulative and complex bodies of knowledge of shellfish gatherings include accurate knowledge of mollusks diversity, habitat and distribution, as well as local environmental characteristics and coastal socio-ecological change. In the other hand, for scientists, mollusks are considered to be performant indicators of ecosystem quality. Participation methods to integrate them in the pool of data information for decision-making.

Shell harvesting was found to be an important subsistence activity in Indonesia and Papua New Guinea. Though, shellfish might be considered to be of secondary importance in the overall diet of coastal societies, it plays a crucial role supplying proteins when faced with environmental fluctuation and seasonal inequalities. In the current context of global and rapid coastal change, shell gatherers can provide thus valuable views, knowledge and observations related to the dynamics of mollusks assemblages and population change within highly sensitive and productive ecosystems as mangroves are coral reefs.

By combining anthropological, geographical (human geography and remote sensing) and ecological approaches, the aim of this communication is 1) to describe the development of ethno-malacological research - considering ecological, cultural and scientific representations - in two different contexts, 2) to examine the applicability of local knowledge in climate and coastal change monitoring and assessment, and 3) to propose participatory ethno-malacological protocols for enhancing local participation in coastal and climate change assessment. Our presentation will be based on research program and fieldworks that are at different stages of realization in Indonesia and Papua New Guinea potential sites for undertaking further comparative research.

**P-4418-06**

**The IRI Data Library: Decision-Making Tool for Climate and Health**

P. Ceccato (1) ; M. Thomson (1) ; B. Blumenthal (1) ; T. Dinku (1) ; M. Bell (1) ; J. Del Corral (1)

(1) The International Research Institute for Climate and Society, Palisades, NY, United States of America

Public health professionals are increasingly concerned about the potential impact of climate variability and change on health outcomes. Protecting public health from climate requires new working relationships between the public health sector and the providers of climate data and information. The Climate Data & Information for Public Health Action initiative at the International Research Institute for Climate and Society (IRI) is designed to increase the public health community’s capacity to understand, use and develop appropriate climate data and information to mitigate the public health impacts of the climate. Significant challenges to building the capacity of health professionals to use climate information in research and decision-making include the difficulties experienced by many in accessing relevant and timely quality controlled data and information in formats that can be readily incorporated into specific analysis with other data sources. We present here the capacities of the IRI climate and
The application of multi-criteria decision analysis in exploring the co-benefits of climate mitigation technologies and scenarios

B. Cohen (1)

(1) University of Cape Town, Energy Research Centre, Rondebosch, South Africa

The MAPS Programme (www.mapprogramme.org) supports developing countries in long-term planning to reduce greenhouse gas emissions. The Programme combines an extensive stakeholder consultation process with deep quantitative research to provide defensible results that have buy-in from a wide range of stakeholders. These results are then used for long-term greenhouse mitigation planning and policy setting. The Programme is currently active in Peru, Brazil, Colombia and Chile, with ongoing activity already having been conducted in a number of African countries.

What has become evident through the projects already implemented in Latin America, as well as ongoing related work in India, is that mitigation planning cannot be conducted in isolation of the consideration to trade-off related co-benefits. For example, there are local co-benefits and impacts that allow for identification of a suitable set of criteria for measuring impacts, qualifying performance of alternatives which do not have natural measurement scales, and for exploring trade-offs in situations with multiple decision makers and sometimes conflicting priorities.

This paper provides a taxonomy of the types of problems and challenges in the climate mitigation space that may be approached using MCDA. These include assessing the co-benefits of individual mitigation options, combining of mitigation options into scenarios, and interpreting the results of modeling of following particular emission trajectories. It then goes on to describe the key components that underpin analysis of problems using an MCDA framework, and how it can be applied to problem structuring and problem analysis. The paper will then highlight two examples of the key errors that are often made in co-benefits analysis – notably use of rating scales and weighting, using relevant examples. Finally, the key limitations of MCDA will be described – notably the time required to conduct a proper engagement exercise and the complexity of the analysis (and hence challenges with communication of results).

Acknowledgements:

This work has been conducted under the MAPS Programme (www.mapprogramme.org) with funding for Children’s Investment Fund Foundation (www.ciff.org). Some of the thinking that underpins this work was developed during a 3-day workshop on the use of MCDA for co-benefits analysis and hence was informed by participants at this workshop. Individuals who participated were: Hernan Blanco, Navroz Dubash, Matthias Ehrhoff, Jose Rui Figueira, Marta Torres-Gunfause, Radhika Kosla, Francisco Molina, Ana Maria Rojas Méndez, Britta Rennkamp, Serban Scrieciu, Ashok Sreenivas, Theodor Stewart, Tanya Visser and Harald Winkler

P-4418-07

Forseeing the evolution of the expertise on climate: some thoughts from the French Association on Disaster Risk Reduction

M. Deves (1); M. Lang (2); PH. Bourrelier (3)

(1) Sciences Po Paris & Institut de Physique du Globe de Paris – Sorbonne Paris Cité, Scientific committee of the french association on disaster risk reduction (afpcn), Paris, France; (2) WITEA, Scientific committee of the french association on disaster risk reduction (afpcn), Lyon, France; (3) AFPCN, Scientific committee of the french association on disaster risk reduction, Paris, France.

The French Association for Disaster Risk Reduction (AFPCN), formerly the French Committee for the International Decade for Natural Disaster Risk Reduction (UN-IDNDR), is a multidisciplinary platform that aims to strengthen the coherency of public policies on disaster risk reduction. One of AFPCN working groups focuses on the risks associated with climate change. At the occasion of the release of the fifth IPCC report, the group re-examined the organisation of IPCC expertise and brainstormed on how it could evolve in the future. This thinking process was based on a review of existing academic literature and on interviews undertaken with top climate scientists (with the support of the French Academy of Science, IPSL, LEGOS or CEA) and the IPCC focal point (former and actual) in Paris. A preliminary report was written and sent off to the public authorities and disseminated to the wider public at the occasion of a study day on July, 9th 2014. Since then, the team has continued to follow up on AR5 results and several study days were suitably set up in 2015 to further discussing, enlarging and strengthening its views.

In this contribution, we propose to communicate the results of this international workshop with the willing of nourishing the science-policy dialogue on what could be a more efficient articulation between research, expertise and decision regarding to climatic issues. IPCC is a unique experience: first, because of its international dimension; second, because it occupies a specific position at the crossroad between science and policy. Evaluating the advantages and the limits of its organisation is key to foresee the evolution of the climatic expertise in the future.

Our analysis focuses on the difficulty to transfer the disparate knowledge of fundamental research, which is organised in specialised disciplines, to build a coherent expert narrative. Today, each of the three working groups of IPCC has a relatively wide field of knowledge to cover and build on a variety of research communities from atmospheric to solid earth sciences, from socio-economy to political science. Each discipline is confronted to different constraints in terms of observational, modelling or conceptual thinking - differences that are not anecdotic but are heritages of different cultural scientific background as well as of the complexity of the real world. The question is whether and how these differences can be accounted for while building a relevant expert narrative. We propose to explore three key steps: 1) the articulation of the working groups, 2) the treatment and communication of uncertainty, 3) the process of successive summarization done from the report to the technical summaries to the Summary for Policy Makers. On that basis we propose leads for amelioration and adaptation for compliance to the needs of the new agreements (COP21 from Copenhagen, Cancun, Lima and will be adopted in Paris.

As we are particularly interested in public policies on adaptation and mitigation, we compare our work with that of IPCC last February. The idea of transferring the expertise on impacts from WGI to WGI seems particularly relevant to us. Additionally, we would suggest developing more works combining adaptation and mitigation. The trend that has led IPCC to produce ever-bigger reports corresponds to a somewhat inductive view of science. In addition to a large expertise on scientific change, it would be important to allow for more focussed works to be undertaken at a variety of scales, involving a greater variety of scientific disciplines and with the contributions from a greater variety of stakeholders (notably the civil society). Workshops and seminars could be organised at the level of the United Nation that could help identifying the research questions to be covered up
in order to answer to the future expertise needs. The scale at which climatic risks, adaptation and mitigation solutions can be thought together in an applicable manner is the scale at which decisions can be taken and applied. Working at a well-though scale on well-designed questions, and with relevant groups of stakeholders, could allow approaching the challenges associated by climate change in a more readable manner. On the side of public policies, it also seems important to explicitly more clearly the interplay between science and policy while going from the large expert reports to the short SPMs.

P-4418-09

Towards a scalable architecture for climate adaptation services: illustration of challenges through future coastal flooding assessments

F. Dupros (1) ; A. Tellez-Arenas (1) ; G. Le Cozannet (1) ; R. Quique (1) ; F. Paris (1) ; F. Boulahya (1) ; S. Leroy (1) ; F. Robida (1)

As climate is changing, more applied information on its impacts is required to inform adaptation planning. It is a fact that during the last decade, the amount of information relevant for climate change impact assessment has grown drastically. This can be particularly illustrated in coastal areas, where a most important recent development has been the availability of precise and accurate topography obtained by LiDAR at regional to national scales. However, these developments have not led to easier assessment of coastal climate change impacts. This is due to (1) the complexity of coastal models that also depend on local natural changes and anthropogenic actions and (2) the difficulty to actually use such large and complex datasets. This raises the following questions: can such complex and heterogeneous datasets be used for an efficient communication of future flooding affected by sea-level rise and climate change? How to communicate the related uncertainties? What infrastructure is needed to support the development of such services?

One of the major challenges in the design of this class of information system is to tackle both the volume and the heterogeneity of the data required to build relevant climate services. Contributions from wingspan projects (Copernicus, EarthCube, EPOS), have demonstrated the feasibility of such architecture. The scalability of the components lying at the heart of these global systems is therefore critical in order to handle large data sets, to integrate complex coastal models and also to deliver more real-time quantitative flooding scenarios. We will therefore discuss several issues related to data architecture at large scale, on-the-fly (geo-)processing capabilities, management of asynchronous workflows and data diffusion and storage in the context of the international standards such as INSPIRE (Infrastructure for Spatial Information in Europe).

We finally describe a prototype of web service to quickly communicate spatial information on future flooding along the French coastal zones that takes into account the related uncertainties. We believe that our flexible architecture, mainly reusing off-the-shelf components is able to improve both complex scenarios analysis for experts and dissemination of these future coastal changes to the general public.

P-4418-10

Science-policy interfaces for climate change adaptation in Vietnam: A Case Study of Quy Nhon City

J. Ghimire (1)

(1) University of Hawaii at Manoa, Department of Urban and Regional Planning, Honolulu, Hawaii, United States of America

Climate science has improved more than ever in the human history. With continuous research at national and international levels, more accurate knowledge of climate change – scenario, models, data and case studies – is being produced. This body of knowledge has crucial role to resolve challenges raised by climate change – sea level rise, severe weather events, extreme temperature, etc. – through mitigation and adaptation measures in policies and plans. But in reality, it is almost impossible to reach on common consensus on use of these scientific knowledge in policy process because the policy choices are so context dependent (Prewitt, Schwandt, & Straf, 2012). Therefore, the role of climate science research is not straightforward on addressing challenges of climate change in plans and policies. In case of climate change adaptation, the use of this knowledge is even more complex because adaptation bears more pragmatic and immediate values than mitigation in the policy process. This paper is trying to improve interfaces between science and policy to effectively adapt with current and future problems posed by climate change, especially among rapidly developing countries where the urbanization and economic growth is surmount. There is very little research exploring science-policy interfaces for effective climate change adaptation in plans and policies in the context of developing countries. This research aims to address this gap using case study of Quy Nhon city of Central Vietnam; where almost all effects of climate change – sea level rise, temperature change, change in precipitation, drought events – are predicted. Studies have shown that Vietnam is 5th most exposed nation to the impacts of climate change where 7 – 12 typhoons make landfall annually. It is also one of the most rapidly transforming countries – economically and socially – in Asia. It has strong institutional and bureaucratic set up for policy formation and implementation as well as for scientific research of climate change. Using more than 30 interviews at Central and at Provincial level among policy makers, climate science policy practitioners, experts, and local political as well as community representatives; this research attempts to identify a pragmatic approach of science-policy interface for climate change adaptation. Major contribution of this research is methodological – to propose an appropriate approach of better interaction between scientific researches and policy processes to address with climate change in vulnerable communities in developing countries, where the formal mechanism of policy implementation are not adequate.

P-4418-11

Sharing skills and needs between providers and users of climate information to enable decision making based on science: lessons from the Northern Adriatic case study

V. Giannini (1) ; A. Bellucci, (2) ; S. Torresan (3) ; S. Caparelli, (4)

(1) Centro Euro-Mediterraneo sui Cambiamenti Climatici, Venezia, Italy; (2) Centro Euro-Mediterraneo sui Cambiamenti Climatici, Bologna, Italy; (3) Centro Euro-Mediterraneo sui Cambiamenti Climatici, Venice, Italy; (4) Comune di Venezia, U.o.c. sostenibilità urbana, Venice, Italy

The growing evidence in support of an anthropogenic influence on Earth’s climate, and the need to cope with the explicit impacts of climate changes on social-economic systems call for a closer dialogue between climate scientists, and the large community of climate information users.

The research described here is focused on an interactive process designed to bridge the gap between climate information providers (i.e. climate scientists) and climate information users (i.e. policy makers, local communities, and public institutions). Bridging this gap means designing a two-way communication, so that mutual learning occurs. Main objective of this research is to analyse the need of new interfaces and methods to improve the communication of climate change impacts on the coastal zone of the Northern Adriatic Sea. The Northern Adriatic coastal zone is considered to be particularly vulnerable to several climate-related phenomena, including meteorological and heavy rain events, pluvial flood, sea-level rise, causing potentially high damages to coastal eco-systems and urban areas (e.g., acqua alta in the Venice Lagoon). The work performed in the framework of this research is methodological – in the CRI M-CLIM project of the EU-funded CLIM-RUN project focuses on the set up of a participatory process designed to understand end-users’ needs, engaging representatives from both the scientific and local communities. This process was facilitated by the Centro Euro-Mediterraneo sui Cambiamenti Climatici (CMCC) acting as a “boundary organisation”.

End-users of climate information were selected among representatives of those public institutions having a
specific mandate for Integrated Coastal Zone Management (ICZM). End-users’ involvement and discussion allowed, since the preliminary phases of the iterative process, to identify which were the end-users’ needs: (1) data to support land-use planning, (2) data with greater resolution and transaction, (3) data on climate impacts and risks, (4) precipitation patterns to improve irrigation, (5) sea level rise and tides to plan ahead both agriculture and Venice defences, (6) climate variations and extreme events, (7) data on local wave and (8) hydraulic data. End-users selected extreme events as the most important climate variables needed, because they are necessary for the development of flood early warning systems, for urban planning, and for Integrated Coastal Zone Management. Based on all needs expressed climate variables were listed in a table and climate products were designed.

Three climate products addressing some of the highest priority needs identified by local end-users were selected. Specifically, climate experts decided to focus on 1) short-term (2020-205) projections of sea-level rise; 2) seasonal predictions of extreme rainfall events; 3) a long-term, regional projections of climate extremes (including heat waves, dry spells and heavy rainfall events). Additionally, two risk products were developed: 4) Sea level rise inundation risk maps for the low-lying coastal areas of Veneto and Friuli-Venezia Giulia regions; and 5) Pluvial floods risk maps for the urban territory of the municipality of Venice.

We can conclude that the dialogue between end-users and climate scientists is still at an early stage, and there are significant opportunities in clearly identifying a common ground where scientifically robust climate information can be effectively translated into a usable product by the end-users community. However, more than lack of information the problem is a mismatch, lack of integration of climate information into the decision making process.

P-4418-12

Transforming Science: The Process and Performance of Scientific Synthesis

EJ. Hackett (1); J. Parker (2); SR. Hespanha (3); E. Cardenas (1); A. Dorr (1); S. Hampton (4); E. Leahey (5); C. Mecklenburg (6); P. Rojas (7); L. Lima (8); V. Liskin-Kalra (9);

(1) Arizona State University, Shesc, Tempe, United States of America; (2) Arizona State University, Barrett honors college, Tempe, United States of America; (3) University of California, Santa Barbara, Nceas, Santa Barbara, United States of America; (4) Washington State University, Pullman, United States of America; (5) University of Arizona, Sociology, Tucson, United States of America; (6) NESCENT, Nescent, Durham, United States of America; (7) Politecnico University of Milan, Milan, North Carolina; Chapel Hill, United States of America; (8) University of North Carolina, Biology, Chapel Hill, United States of America

Transforming science is a term meant to be understood in two senses. In one sense it means changing the way science is organized and done; in another sense it means producing a form of science that may transform what we know and can do. Achieving transformative solutions to sustainability challenges will require transforming science in both senses of the term: we will need new forms of scientific knowledge and inquiry and we will need scientists to organize and collaborate in new ways to produce such knowledge. Synthesis centers offer promising possibilities for transformations of both sorts, achieved through intense and focused collaboration across academic fields and across the sectors of science and public policy. This talk describes the inner workings of two organizations that promote scientific synthesis, analyzing their structures and consequent patterns of interaction to understand why they work well and to draw lessons for the design and operation of other such centers. To do so we measure collaborative process in new ways – using sociometric sensors – and analyze surveying a topic models of publications from synthesis centers and a reference corpus of articles from cognate fields. We summarize our findings in a model of intellectual fusion that captures the principal dynamics of the process.

P-4418-13

Towards more consistent assessments of country-level impacts of climate change

L. Horrocks (1); G. Wilkins (1); S. Winne (1); J. Lowe (2); H. Mcgray (3); J. Cook (4);

(1) Ricardo–AEA, Adaptation and climate resilience, Didcot, Oxfordshire, United Kingdom; (2) Met Office Hadley Centre, Climate knowledge integration, Exeter, United Kingdom; (3) World Resources Institute, Vulnerability & adaptation initiative, Washington DC, United States of America; (4) UK Department of Energy and Climate Change, Climate science and international, London, United Kingdom

Vulnerability and impacts assessments contribute evidence to shape and support action to tackle climate change at various levels. However, there is currently no international process for presenting information about climate impacts consistently at the national level. The lack of consistency makes it hard to compare results from different assessments and different countries, and it can be challenging to attempt a synthesis at the country level, given absences of standardized approaches, data availability, timescales, descriptions of sectors, etc. International cooperation on cross-border impacts can be especially challenging when assessments in different countries lack consistency or transparency in respect of assumptions and methods.

The level of ambition for national assessments is constrained by multiple factors within countries, including research budgets, technical capacity, data availability at appropriate spatial and temporal scales, political priorities, and uncertainty over best practice methods. Approaches to country-level climate impacts and assessments span a spectrum including top-down modelling of impacts in sectors, expert synthesis, and bottom-up stakeholder-led risk aggregation and prioritization. Even within individual countries, approaches for national assessments have evolved over time.

Previous studies have shown that greater consistency in the assessment and communication of climate impacts and vulnerabilities at a country level is both possible and desirable. A UNEP-UK Country level impacts of climate change (CLICC) project is now addressing this. It is facilitating the co-creation of a common process with a range of countries to enable them to present their own climate change impacts and risks in a more standardised way. The CLICC initiative brings together the needs of multiple countries and an international process supported and coordinated at the international level, rather than simply to deliver a one-off suite of information products.

Participating countries represent a range of economic development and geographies. Some of the benefits identified by countries during consultations include: (1) more effective information-sharing on climate impacts, leading to enhanced collaborative research and action, especially in relation to trans-boundary impacts; (2) expansion of common approaches for climate change assessment; (3) generation of good practice and collective learning, through improved transparency around methods, assumptions, data sources and limitations in assessing impacts; (4) consolidation of existing studies and findings within countries, also contributing to a more detailed picture of the global risks from climate change; (5) country-level contributions to the evidence base, especially in technical or financial capacity, or approaching their limits of adaptation.

This conference presentation will provide an overview of the achievements of the CLICC project so far, including the results of consultation with more than 30 countries. It will explain the principles that CLICC has established to ensure a successful and holistic approach to multiple countries addressing multiple impacts in distinctive contexts. These include:

- Maintaining country control over content and communication of their impacts information
- Maximising inclusivity regardless of countries’ current capacities
- Minimising the burden and avoiding parallel institutions or obligations
- Promoting good practice, enabling quality control and signposting research needs

CLICC has considered both qualitative and quantitative formats to achieve greater consistency in the communication of results, and the importance of metadata has been underlined. We will present the CLICC options
The environmental domains are identified using specific environmental domains into conservation strategies. We propose a method to incorporate climate-dynamic specific information make it impracticable to develop South Africa, occurs in one of the biodiversity hotspots of based on static spatial plans which do not adequately account for dynamic threats such as climate change and edaphic disjunctions. Species with specific soil requirements may still be able to track changing climatic conditions. Using the identified environmental domain and magnitude of change maps, a vulnerability framework was developed to inform appropriate conservation actions to mitigate climate change impacts on biodiversity. The framework incorporates climate-induced changes, and the magnitude of the environmental change is another major global change factor in the province. The mean magnitude of change expected in each domain formed the third dimension of the framework which indicates the potential vulnerability of that domain. The study explicitly links floristic pattern and climate variability and provides useful insights to facilitate conservation decision making for climate change.

Multi-model, multi-method, information for decision making

C. Jack (1)
(1) University of Cape Town, Environmental and Geographical Science, Cape Town, South Africa

Despite continual advances in our understanding of the climate system and climate change, continual increases in complexity of earth system models, and continual developments in both dynamical and statistical downscaling methods, decision makers continue to be presented with a diversity of contradicting and often highly uncertain information regarding potential changes in climate with respect to their decision context. Added to this is the increasing complexity of the information needs of decision makers as they consider a range of time scales, spatial scales, and complex system interactions in their day to day and long term strategic decision making. Urban centres are growing quickly in developing nations facing severe water resource constraints, and yet stand out at key points of risk and vulnerability under future climate due to rapid urbanisation, pressure of natural resources, and critical limitations on governance and administration.

It is therefore critical that the most robust and, critically, defensible, information is available to decision makers and that this information is made available that facilitate co-production of knowledge, rather than just supply of knowledge. This is a significant challenge. This paper presents some initial work being done at the University of Cape Town to develop a framework to appropriately provide the scale and context appropriate information from a diversity of global climate models (CMIP5), regional dynamical downscaling (CORDEX) and regional statistical downscaling (CORDEX-ESD). The method presented allows for rapid and continual exploration of the diversity of information and so facilitates co-production. The approach allows for the specification of certain characteristics of the information required (variables, scales, multi-variate characteristics, spatial scales, temporal scales and time horizons, etc.) and uses these requirements to interrogate the diversity of source data and signals in such a way as to extract the most defensible messages.

It is explicitly acknowledged that the resultant messages may still contain contradictions, and that some levels of uncertainty due to natural variability or model inadequacy is irremediable given the available data.

Climate induced environmental domain change; informing conservation decision making in KwaZulu-Natal, South Africa

D. Jewitt (1)
(1) University of the Witwatersrand, School of Animal, Plant and Environmental Sciences, Johannesburg, South Africa

Climate change is having marked influences on species range distributions, ecosystem composition and phenology. This raises questions as to the effectiveness of current conservation strategies and conservation planning, the central tenets of which are representivity and persistence of species. Conservation planning is currently based on static spatial plans which do not adequately account for dynamic threats such as climate change and thus cannot ensure the persistence of species. KwaZulu-Natal, a province occurring on the eastern seaboard of South Africa, was one of the biodiversity hotspots of the world. This high diversity and the paucity of species specific information make it impracticable to develop individual climate adaptation responses for all species. We propose a method to incorporate climate-dynamic environmental domains into conservation strategies. The environmental domains are identified using specific environmental correlates of floristic composition in the province, which were temperature, soil base status and precipitation variables. The environmental domains represent the metaphorical stage of the province whilst recognising that species constituting the diversity may change through time. This offers an approach to conserve biodiversity under current and future climates. Current domain locations were mapped by identifying their positions in a multi-dimensional environmental space using a non-hierarchical hierarchical clustering algorithm. Their future locations were explored using an ensemble of six different dynamically downscaled Coupled Global Climate Models based on the A2 emission scenario. The HadCM2 and GFDL2.1 models represented the extreme ranges of the models. Domains occurring in savanna biomes increase at the expense of domains occurring in the grassland biomes. This has significant negative consequences for species dependent on grasslands. Euclidean distances were used to determine the magnitude of change in each environmental domain. The magnitude of change models identify areas of greatest and least stability for future climate projection, and represent areas of changed climatic conditions or edaphic disjunctions. Species with specific soil requirements may still be able to track changing climatic conditions. Using the identified environmental domain and magnitude of change maps, a vulnerability framework was developed to inform appropriate conservation actions to mitigate climate change impacts on biodiversity. The framework incorporates climate-induced changes, and the magnitude of the environmental change is another major global change factor in the province. The mean magnitude of change expected in each domain formed the third dimension of the framework which indicates the potential vulnerability of each domain.

In association with the new European space programme (Copernicus), the European commission is promoting the development of a climate information platform which should supply comprehensive, reliable and consistent information for stakeholders.

The FP7 project “Climate Information Portal for Copernicus” (CLIPC) is developing a demonstration portal for the Copernicus Climate Change Service (C3S). This project is one of a suite of FP7 research activities which are administratively independent of Copernicus, but creating the technical and scientific building blocks needed for the service. There are dozens, if not hundreds, of climate portals already offering a variety of products to a confused user community. It would be unwise to attempt to re-invent all this creative activity with a single portal – instead CLIPC is designing a portal to make distributed resources more accessible through flexible discovery systems. CLIPC needs to deliver more than a single directory of resources: resources need to be presented in a consistent format so that users can access multiple datasets.

More information about the project objectives is available at www.clipc.eu. The gap between the climate science communities and the end user communities is a central challenge being addressed in the project. It is important to understand that there is significant diversity and multiple communication barriers within these two sets of communities as well as between them. The CLIPC services must presentation will provide a review of progress towards this ambitious goal through the delivery of the project activities, an overview of the proposed architecture, work on assessing and adjusting model biases, and a discussion of the climate impact indicators which will be provided through the portal. We will be making a list of data for the various users, CLIPC will implement a set of services functioning as a “knowledge base” supplying information to users about the data, including definitions of terminology used, quality of datasets, versioning, and user annotations.
P-4418-17

Cooperation on climate change - Under economic linkages - How the inclusion of macroeconomic effects affects stability of a global climate coalition
J. Kersting (1); M. Weitzel (2); V. Duschka (1)
(1) Fraunhofer Institute for Systems and Innovation Research, Karlsruhe, Germany; (2) National Center for Atmospheric Research, Boulder, CO, United States of America

Game-theoretic models of international cooperation on climate change come to very different results regarding the stability of the grand coalition of all countries, depending on the stability concept used. In particular, the core stability concept produces an encouraging result that does not seem to be supported by reality. However, current implementations of this model are based on the assumption that a country's consumption loss due to emission abatement measures only depends on the country's domestic emissions. This approach neglects international macroeconomic effects of emission reduction measures, such as technology spillovers or changes in fossil fuel prices. We extend the game-theoretic model based on the core stability concept by introducing these effects into the model. The computable general equilibrium model DACE and the game-theoretic RICE model are used to quantify the theoretical model. Contrary to the classical model, we find that the core of the resulting cooperative game is empty and no stable global agreement exists. This is mainly driven by countries, which are negatively affected by lower fossil fuel prices resulting from global emission reduction measures. Also, other countries do not have a sufficient incentive to compensate fossil fuel exporters for their participation in a global agreement, because the gains of further cooperation are small. We also find that, if damages from climate change are assumed to be high, countries with comparatively low projected damages are a hindrance to global cooperation. Our results point to two alternative ways forward in the climate negotiations. The first option calls for a «coalition of the willing» among countries, mainly fossil fuel exporters, for participation in a global agreement. As we found that no stable global agreement exists, such compensation would not be rational, if the decision is based purely on a benefit-cost analysis of GHG abatement. However, if other arguments such as fairness principles are taken into account, the necessary compensation might be justifiable. The second option calls for the «coalition of the willing» to abandon the UNFCCC process and to try to consummate an agreement among this coalition. This option could come close to the environmental effectiveness of the grand coalition.

P-4418-18

Development of an interactive, multi-objective decision support system in South Africa
T. Lane-Visser (1)
(1) Energy Research Centre, Cape Town, South Africa

Climate change, and the decisions to be made regarding the management thereof, is inherently complex and multi-faceted. How we deal with the complex world we live in, is but one of many complexities – there are many other essential systems and pivotal issues with which it interacts. Going forward, decisions will not be based on the traditional decision making, unless or nor should it be based on a single criterion (which ignores the knock-on impacts of a decision in terms of other criteria). To be defensible and responsible, decision makers need to be cognisant of the full set of climate change impacts before making a final decision. Myopic decision support systems often, inadvertently, do more harm than good in the long run. Multi-objective decision support has been developed to try and overcome this problem.

Generally, a country's energy generation and consumption is key in determining how much greenhouse gas emissions. The TIMES model generator, a widely used country-wide energy planning tool, was developed as part of the IEA Energy Technology Systems Analysis Program, an international consortium which uses long term energy scenarios to conduct in-depth energy and environmental analyses. The TIMES model generator combines two different, but complementary, systematic approaches to modelling energy; a technical engineering approach and an economic approach. It is a technology rich, bottom-up model generator, which uses linear-programming to produce a least-cost energy system, optimised according to a number of fixed user constraints, to suit different planning time-horizons. In a nutshell, TIMES is used for the exploration of possible energy futures based on contrasted scenarios. The model makes equipment investment decisions and operating, primary energy supply and energy trade decisions, by region. This outputs an optimal mix of technologies and fuels at each period, together with the associated emissions to meet the demand. The model uses scenarios to do what if analysis, and does not optimise for anything other than costs.

The first part of this presentation chronicles the conversion of SATIM, a South African calibrated version of TIMES, from a cost only to a bi-objective (initially) and multi-objective (ultimately) optimisation model. The practicalities of such a conversion, along with the obstacles encountered and ways to surmount said obstacles, are discussed. This conversion was part of a MAPS South Africa initiative to create a multi-objective energy sector planning model for South Africa. The benefit of having such a model is the ability to study trade-offs and to provide more rich data for decision makers. The second part of the presentation will demonstrate and elaborate on the enrichment of data outputs thanks to the expanded model.

P-4418-19

Communicating uncertainties of future coastal impacts for decision making
G. Le Cozannet (1); J. Rohmer (2); A. Cazenave (3); D. Ider (4); F. Lavigne (5); C. Oliveros (2)
(1) BRGM / CNRS, BRGM-DRP-R3C / CNRS-LGP (UMR-8531), Orleans, France; (2) BRGM, Orleans, France; (3) CNRS-CNES, Laboratoire d'études en géophysique et océanographie spatiales, Toulouse, France; (4) BRGM, Orleans, France; (5) LGP, Orleans, France

As sea-level rises, coastal hazards and risks such as extreme flooding or erosion are changing. For accurate assessments, several factors must be considered, such as the vulnerability of sea-level rise exposure. We proceed to a global sensitivity analysis of future coastal impacts of sea-level rise, in order to provide quantitative insight into the relative importance of contributing uncertainties over the coming decades. The method is applied for typical coastal settings of high- and low-energy coasts. Storm surge propagation processes, then sea-level variability, and, later, global sea-level rise scenarios become successively important source of uncertainties over the 21st century. This defines research priorities that depend on the target period of interest. On the long term, scenarios RCP 6.0 and 8.0 challenge local capacities of adaptation for the coastal decision makers concerned with adaptation to climate change in coastal areas, this approach provides quantitative insight into three key issues related to: (1) the timeliness of coastal adaptation planning (2) the sensitivity of the decision system by which rising sea-levels cause rapid obsolescence of regular adaptation measures (3) the constraints imposed by different future climate change scenarios for long-term adaptation planning.
Climate services for adaptation to climate change in a developing country: case studies from South Africa and Burkina Faso

M. Lugen (1)
(1) Université Libre de Bruxelles, Centre d’études du développement durable (cedd), Brussels, Belgium

Background and objectives: Adaptation to climate change (CC) is an issue growing rapidly, one reason being the observation and projection of negative impacts highly challenging human societies and ecosystems. Adaptation to CC in developing countries is highly needed, as the lack of effective and understandable climate information is regularly emphasized. Many initiatives to implement climate services have emerged in recent years to respond to this need, especially in developing countries. According to the World Meteorological Organization, climate services aim to « provide climate information in a way that assists decision-making by the users and organizations ». My PhD project has a multidisciplinary nature and aims to understand whether, and if so in what ways, climate services may represent a first step towards the development of adaptation strategies at the local level. This research is based on a bottom-up approach, and has for main hypothesis that using climate services for the development of adaptation strategies requires to meet certain criteria (relevance, ease of access, understanding, integration) associated with a participatory approach for the construction of information, taking into account contextual aspects of vulnerability to CC. More specifically, this thesis will focus on the interactions between climate services providers, users and final beneficiaries for one part, and the communication tools used to broadcast the information for the other part. I pursue this way the goal to analyze the design of consistency between the ‘supply’ and ‘demand’ in terms of climate information, both for content and communication structures, and therefore understand whether CS can be a first step towards adaptation to CC. This will serve to formulate recommendations or alternatives in order to improve the reconciliation between the bottom and the top on that matter.

Methods: The methodology (that will be described in more details in the poster) will be applied to two case studies. The first one is South Africa (1), in the province of Western Cape, where a multidisciplinary research center at the University of Cap Town acts as climate service and collaborates with public local stakeholders. The second one is Burkina Faso (2), where two climate services projects are currently being implemented targeting adaptation in rural communities. Both countries present high degrees of vulnerability to climate change, although different internal contexts influence the distribution of adaptive capacities and social vulnerability. I first want to highlight internal logics coming from the building of climate services at the level of suppliers (scientists) and users (administration and technical agents involved) of climate services; then identify demands from final beneficiaries (local public stakeholders and rural farmers in our case studies) through qualitative investigations carried out locally. Data will be collected by means of semi-structured interviews (for all actors) and participatory workshop (for beneficiaries). The selection of those key stakeholders will be a crucial point of the research, and particular attention will be given to what some authors have called « weak » or « observers » stakeholders, traditionally excluded from participating in consultative decision-making processes. The understanding of contextual factors forcing social vulnerability to CC, as well as interactions between all actors involved in building climate services, will be two major points of attention in this project.

Results: I will present early results from the analysis of a field case study in South Africa (case study 1) as well as highlights about adaptation to climate change in Burkina Faso (case study 2) on the basis of a previous field research conducted in this country in 2012. I also intend to present an empirical typology of climate adaptation services in Africa. This PhD project is in its first year, research is then on-going and new points may be included later on.
French Guiana and Brazil, portal of a future malaria sentinel site of the Brazilian observatory on climate and health, iii) Mayotte and La Réunion: surveys to investigate the inequalities and choices that drive the use of health care; development of a method to spatially anonymize georeferenced individual data; creation of an early warning system for forecasting malaria outbreaks. We also situate this project within the worldwide initiatives context.

We analyse the benefits of such an approach but also the related obstacles (e.g. data sharing) and technical issues (e.g. multiscaling, complex modelling).

**P-4418-23**

**Robust technological and emission trajectories for long-term stabilization targets with an energy-environment model**

C. Nicolas (1) ; S. Tchung-Ming (1) ; E. Delage (2) ; O. Bahn (2)

(1) IFPEN, Economics, Rueil, France; (2) HEC Montreal, Decision sciences, Montreal, Canada

In order to inform decision makers and to evaluate climate policies, the use of integrated assessment models (IAMs) is now widespread and common. These models are particularly used to identify promising technological pathways (Labriet et al., 2009), to evaluate various climate policies (Hu et al., 2012) or to assess the impact of policy measures on resource exhaustion (McGlade & Ekins, 2015).

Climate change being a recent and complicated field of research, the last decade brings multiple answers regarding the climate system evolution but raises also a lot of new questions that still need to be addressed by physicists and climate scientists. The imperfect knowledge of global warming mechanisms and the large variety of IAMs lead the model users to reach conclusions sometimes very different.

This lack of robustness across models leads some economists to disregard the use of IAMs. Pyndick (2013) states that the cited literature is too idiosyncratic and differences surrounding the climate system behavior or the impacts of climate change on economic aspects and the inability of IAMs to consider very low probability/catastrophic outcomes events, the IAM–based analysis of climate policy creates “a perception of knowledge and precision that is illusory and misleading”. Hence, it seems absolutely necessary to make uncertainty a core feature of long-term, climate-related policies. Identifying and modeling uncertainty sources that can be addressed by robust techniques to solve large-scale problems contaminated with “massive data uncertainty”.

Motivation Stochastic optimization (SO), sensitivity analysis and deterministic multi–scenario analysis have been applied to tackle this uncertainty issue. SO allows to encapsulate uncertain parameters and to provide an explicit hedging strategy while the other methods stay deterministic. One drawback of SO is that it requires to know the probability distribution of the uncertain parameter which is not always possible. Another drawback of all these methods is that they become rapidly intractable as problems grow in size.

In this work, we introduce an alternative way to tackle uncertainty in energy system models. We focus on robust optimization (Ben–Tal et al, 2009) to make many model parameters simultaneously uncertain. So far, this technique has been scarcely used in energy modeling (Bouwmeester et al, 2012) and is currently focused on (moderate) system modeling because of its large uncertainties and the numerous criticisms it faces.

Methodology In this study, we use the TIAM–World model (Loulou, 2008) that relies on the TIMES paradigm. Often used to analyse climate change policies or objectives, this model contains a climate module inspired by the DICE model. Using robust optimization techniques, we assess the impact of the climate system parameter uncertainty on energy transition pathways under climate constraints. Unlike other studies (Syri et al., 2008, Labriet et al., 2015), we consider all the climate system parameters.

This is of primary importance since (i) parameters and outcomes of climate models are all inherently uncertain (parametric uncertainty) and (ii) the simplified models at stake summarize in a (sometimes linear) few equations phenomena that are by nature complex and non linear, so that structural uncertainty is also a major issue.
P-4418-24

Information Technology in management of social-economical estimation of the flood affects and water quality in the Central Asia

P. Normatov (1)
(1) Tajik National University, Water resources, Dushanbe, Tajikistan

The aspects of water allocation between the countries of Central Asia are considered from the point of view of river basin hydrology. The decision of ecological problems, the creation of a new system of water control and management is of special interest. The Commission of Transboundary Rivers is offered in the region.

Water relations between Central Asia republics during the Soviet Union time were regulated by “Complex Use and Protection of Water Resources Schemes” in Amudarya and Syrdarya basins. The main purpose of working out basin “Schemes” was to define real volumes situated within the Amudarya and Syrdarya basins and available for using water resources. It was also providing their fair allocation among region republics, meeting all the water users’ interests. It should be noticed, that the number of important aspects were not considered and included in “Schemes”, for the situation has greatly changed after 1980 (years of the last “Schemes” specification and completion of hydraulic range composition). Mainly it concerns the ecologic acquirements and sanitary clears thrown into rivers and channels. Overusing basin water in irrigational lands planned as maximum use by “Scheme” resulted in exhausting water resources and appearing new problems. They are:

- Deterioration of ecological condition sometimes leading to ecological disaster in downstream of rivers of Aral Sea Basin;
- Great pollution of river water with pesticides, herbicides, other harmful elements and increasing of water mineralization.

Among all the regions of Tajikistan 93 % of territory is irrigated. The construction in the Zarafshan River Basin the formation of floods is observed most often (almost 7% of the total across Tajikistan) and their average number in a year reaches 150. More than 300 thousand inhabitants live in this basin; located in the Aini and Penjikent regional centers. The local population is affected almost annually with great economic losses.

Nowadays one of the most polluted rivers of Central Asia is Zarafshan River. The basin is divided into the river’s influence by collector drainage water of irrigating basin zone and wastewater of Samarqand, Tashkent, and Bukhara cities. Mineralization of water exceeds from 0.27-0.30g/l to 1.5-1.6 g/l. It gives the ground to hope, that the problem of contamination and ascending of a degree of water arteries mineralization can be solved with the same success by structural subdividing Basin of Central Asia the water quality control statistics in industrial, agricultural, municipal sectors and Hydroposts are gathered, generalized and systematized. Thus, the data concerning water arteries quality from each country come to Analytical Center of ICWQC.

It should be noted that after reaching the complete transparence of relative composition and quality of all water arteries in Central Asia the next stage is the development of mechanisms to encourage and take measures to the states polluting water environment. These problems together with other issues should be studied in ICWQC Secretariat for considering at Meeting of Central Asia Heads of Governments.

P-4418-25

Balancing Short- and Long-lived Climate Pollutant Mitigation: Clearer Metrics are Critical

I. Ocko (1), S. Hamburg (2), S. Pacala (3)
(1) Environmental Defense Fund, Office of Chief Scientist, New York, NY, France; (2) Environmental Defense Fund, Office of chief scientist, Boston, NY, United States of America; (3) Princeton University, Ecology and evolutionary biology, Princeton, NJ, United States of America

Any effective program to address climate change must reflect a well-balanced effort to reduce emissions among a suite of climate pollutants, including carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), various fluorocarbons (e.g. HFCs), and black carbon, as their radiative effects and atmospheric long lives vary by orders of magnitude. However, confusion among policy makers about how to attain the optimum balance required to achieve the desired climate benefits has increased dramatically in recent years, in large part because of the way in which climate metrics, Global Warming Potentials (GWPs), are reported in the scientific literature. This confusion is particularly evident in the public and political debate over the expansion of natural gas production in the United States and its use to replace coal in the generation of electricity. Understanding the climate impacts associated with this fuel switching over time is an important and unnecessary source of acrimony. We propose a simple change in the convention used in reporting GWPs that we believe will significantly reduce confusion about the implications of a host of policy decisions. Rather than picking a single time period over which to report the cumulative radiative forcing caused by an emission, typically 100 years (GWP100), we propose that the scientific community adopt the convention of reporting climate impacts as a blended pair: GWP20/GWP100, much the way systolic and diastolic blood pressures are reported to help clarify short- and long-term temporal tradeoffs that are at the heart of much of the confusion.

P-4418-26

Surpassing cognitive barriers for an international climate agreement: Communication matters

C. Pillay (1)
(1) Universidad Autónoma de Barcelona, Institute of Science and Technology, Barcelona, Spain

Individual perceptions of climate change should matter for the design of international agreements and domestic climate policy. Especially responses to uncertainty will determine whether one can gain support for climate policy, let alone for an agreement. Communication of its potential to garner just this. This paper addresses the individual mind and how it reflects the interests of various actors, be it governments, businesses or international organizations, by focusing on singular cognitive barriers to the aping of the existing literature on behavioural decision-making, two cognitive barriers that seem to get in the way of a desired climate agreement are highlighted: positive illusion and interpreting behaviour in a self-serving manner. Positive illusions serve as a necessary buffer for human beings in dealing with
negative information about potentially disastrous future developments. In the context of climate change, unrealistic optimism and the illusion of control stand in the way of climate policy. This can explain an array of behavioural responses among various actors. For instance, the reason for climate change scepticism; or the overreliance on technological solutions without needing to change individual behaviour. With regard to the second cognitive feature, it is in human nature to behave in a self-interested manner, more so when faced with potential risks like food security, oil and clean air. The agreement should be communicated in a way that does not instill such perceptions but instead should focus on the numerous co-benefits of climate mitigation policies. For instance, the results of the 2015 agreement are designed to go into effect well into the future with many possible co-benefits. This gives time for preparation and advancement of domestic climate policy. The United Nations Framework Convention on Climate Change (UNFCCC) has even launched a pre-2020 workplan to raise mitigation ambition by highlighting the benefits of action. Nevertheless, the agreement/climate policy is frequently viewed as costly whilst inflicting unwanted immediate self-anxieties that end up blocking such imperative policies unnecessarily. Thus communication which pays attention to words used influences expectations and information processed cognitively by a person.

The paper ends with solutions and tentative proposals on improving this so-called ‘behavioural decision-making perspective along with its contribution and important implications to the ever emerging trans-disciplinary framework in tackling barriers towards an international climate agreement.

**P-4418-27**

**An integrated framework for climate vulnerability, and natural hazards & risks assessment at the local scale - and its potential for regional upscaling**

N. Salzmann (1); S. Allen, (2); K. Awasthi, (3); C. Huggel (4); M. Ali Khan (3); A. Linsbauer (1); M. Rohrer (5); M. Stoffel (6); A. Gupta (7); N. Mendiratta (7); J. Kuriger (8)

(1) University of Fribourg, Department of Geosciences, Fribourg, Switzerland; (2) University of Zurich, Department of geography, Zurich, Switzerland; (3) Indian Himalayas Climate Change Adaptation Programme, New Delhi, India; (4) University of Zurich, Department of geography, Zurich, Switzerland; (5) Metedat GmbH, Zurich, Switzerland; (6) University of Geneva, Institute for environmental sciences, Geneva, Switzerland; (7) Department of Science & Technology, New Delhi, India; (8) Swiss Agency for Development and Cooperation SDC, New Delhi, India.

The Indian Himalayan Region (IHR) as many other (mountain) regions worldwide is facing important challenges in view of coping with adverse effects of climatic changes. In order to address adaptation needs and reduce the vulnerability of the communities living in potentially affected areas, the Indian Government Mission on Sustaining Himalayan Ecosystem (NMSHE) is targeting an integrated vulnerability and risk & hazards assessment encompassing the 12 Indian Himalayan States. The assessment will serve as an important basis for prioritizing, planning and implementing adaptation measures at State/ sub-national level.

The Indian Himalayas Climate Adaptation Programme (IHACP) of the Swiss Agency for Development and Cooperation SDC, being implemented in partnership with Department of Science and Technology (DST), Government of India, is supporting these efforts through high scientific and technical knowledge cooperation between Swiss and Indian scientific institutions. A first step includes the development and implementation of an integrated and comprehensive framework for climate vulnerability work for climate vulnerability assessment and natural hazard and risk assessment in a pilot region of the IHR. Kullu district in Himachal Pradesh, India, has been identified as climate hotspot and as such represents an ideal pilot region.

The framework for Kullu is based on the recent concept of Integrated Climate Services (ICS) and have links and supports to the Intergovernmental Panel on Climate Change (IPCC; AR5, SREX). Specific joint Indo-Swiss collaborative studies are in progress in Kullu covering thematic themes such as climate, cryosphere, floods, agriculture, perception, tourism, forestry and biodiversity. Fundamental for integrated vulnerability assessments is a common baseline and thus particular care was addressed to the definition and agreement for a common time window and homogenous datasets (climate, socio-economic, environmental) for all studies conducted within the framework. With regard to the time horizon, the baseline refers ideally to a relevant time horizon of their livelihood and must span a climatological period of preferably 30 years (WMO standard). For Kullu, the time window 1981–2010 was chosen.

In this contribution, we present the framework for the Kullu region, related results from specific thematic studies and discuss in particular the potential and limitations of the upscaling processes towards a common framework for integrated vulnerability and risks & hazards assessment for the IHR.

**P-4418-28**

**Integrating Research and Practice - What Climate Service can learn from other Fields**

S. Schuck-Zöller (1); M. Bergmann, (2); C. Brinkmann, (3); JT. Huang-Lachmann, (3); S. Rodder, (4)

(1) Helmholtz–Center Geesthacht, Climate service center 2.0, Hamburg, Germany; (2) SOE - Institute for Social-Ecological Research, Frankfurt, Germany; (3) working for: Helmholtz–Center Geesthacht, Climate service center 2.0, Hamburg, Germany; (4) University of Hamburg, Centre for globalisation and governance & center for earth system research and sustainability, Hamburg, Germany.

Climate change and its widespread impacts are a challenge for both science and society. To find sustainable solutions and develop adaptation strategies, a transdisciplinary approach to this challenge is needed. Climate service is bridging the gap between climate research and practice. This integrated research relies on intense communication between various players in science, politics, economics and administration. So – by nature – climate service is transdisciplinary.

Some fields now have a tradition of integrating practice partners, but so far, there is hardly any integration of knowledge and experiences on the meta–level. Rather, the terminology, concepts and references that are used are very diverse. Neither theoretical insights nor empirical case studies on transdisciplinary communication in different fields have so far been systematically reviewed.

To evaluate in how far climate service can benefit from existing approaches to transdisciplinarity, a literature review has been carried out. Its aim was to better understand definitions, approaches, methods, and barriers of the different fields, such as Climate Service which is bridging the gap between science and practice. For this purpose, a range of approaches and studies on transdisciplinary communication in different fields have been systematically reviewed.

The presentation will both, sum up the results of the literature review and the outcomes of a recent conference, which collected experiences on transdisciplinary communication in different contexts, such as public health, environment protection, sustainability, and climate change. A special focus lies on aspects of social-ecological research and stakeholder engagement in climate change adaptation.

**P-4418-29**

**Managing Risks? Early Warning Systems for Climate Related Hazards**

A.Sitati (1); Z. Zommers (1); M. Habilov (1); A. Vanzanten (1); E. Vogel (1)

(1) United Nations Environment Programme, Division of Early Warning and Assessment, Nairobi, Kenya.

Early warning systems are a tool with which to minimize risks posed by climate related hazards. Although great strides have been made, early warning systems most deal with one hazard, only provide short-term warnings and do not reach the most vulnerable. This presentation will review research results of the United Nations Environment Programme (UNEP)’s CLIM-WARN project. The project has sought to identify how
governments can better communicate risks by designing multi-hazard early warning systems that deliver actionable warnings across timescales. Household surveys and focus group discussions were conducted in 36 communities in Kenya, Ghana and Burkina Faso in order to identify relevant community related hazards and early warning communication options. Preliminary results show significant variability in risks and needs within countries. Here there is critical need for advanced warning so that adaptive measures can be taken. Some regions have limited access to information through TV or SMS. Here traditional institutions, such as chiefs and meteorological extension officers, will be critical for warning delivery. In contrast, in urban areas mobile phones may be an effective way to deliver warnings and spread information about risks. Communities should be involved in early warning system design so appropriate communication channels, and trusted groups, are used to deliver warnings. There is a need for flexible warning systems that address community specific needs and deliver broad information about risks. Information disseminated through early warning systems should not only include details of hazards, but also short-term response options and long-term adaptation options, thus increasing both capabilities and response options.

P-4418-30

Water Related Disaster Risk Reduction (DRR) Management Strategies in the United States: Climate Adaptation to Floods and Storm Surges

EZ. Stakhiv (1)

(1) Institute for Water resources, Johns Hopkins University, Baltimore, MD, United States of America

Water resources planning and management has evolved in the United States through several distinct stages over the past two centuries, transitioning from a concern for inland waterways transportation to single purpose flood control and finally to multiple purpose large reservoirs. DRR or disaster reduction (DRR) – which seeks to reduce societal vulnerability and loss of life – were always the main goals of these strategies, as an integral part of a US Federal system that presents major challenges to coordinating water resources development and flood protection in a way that meshes with other resource uses in an area scales. Equally, the underlying and inherent climate-based components of risk and uncertainty comprised the scientific basis of assessment and evaluation of management strategies.

The relative performance of existing flood protection systems of three recent disasters are presented; Hurricane Katrina (2005), Superstorm Sandy (2012) and the Long Term Adequate Mississippi River flood (2011). The cases revealed new vulnerabilities and weaknesses in the US DRR responses and planning, while contrasting the relative successes of long-term, strategic DRR planning and flood investments in the case of the Mississippi River and Tributaries system.

Today, the underpinning of DRR in the US is risk-based decision making, which is distinct from traditional water resources multi-objective decision making. This new paradigm maximizes social well-being, public safety and risk-reduction strategies for the local populace, subject to numerous environmental constraints (and preferred solutions), leading to what could be termed ‘sustainable development’.

The new ‘risk-informed decision making’ culture is far more complex. It is based on risk–cost comparisons and tradeoffs among various options. It engages the affected public. This strategic DRR planning requires a great deal more complex and technically sophisticated information and attention of the public – not just the analysts and decision makers. As a consequence, the public is also asked to bear more of residual risks and costs, without often fully understanding the consequences.

OVERALL LESSONS LEARNED FROM THE THREE RECENT MEGA-DISASTERS

a. Disaster risk reduction comprises a special category of flood management, as it connotes extremely large events, with catastrophic human consequences and national level economic impacts.

b. Conceptually, federal systems should be able to deal effectively with such events, but a series of recent disastrous floods and storm surges in the US has exposed some of the weaknesses in the response of federally-based disaster management systems.

c. Risk-based decision making at the local level is neither replicable nor uniform. It is not at all clear, whether a collection of loosely connected local solutions, with varying degrees of risk and uncertainty, can guarantee either robustness or resilience. The recent responses to Katrina and Superstorm Sandy reinforce that public confusion.

d. Residual risk is almost always underestimated because it is difficult to quantify a cascading series of highly interdependent measures, each of which has its own reliability characteristics and risk of failure.

e. A flood protection system is a collection of fragmented measures, including new building codes, zoning ordinances, and structural measures that are implemented over a long period of time and loosely coordinated by multiple authorities. This comprises the definition of a ‘brittle system’.

f. Because people bear the risks, their involvement in choosing risk and participation in the tough operational decisions made during the process of planning for mitigation of potential events is critical to the health of a democratic system

P-4418-31

Climaps.eu an Online Platform for Informing Decision-Making

T. Venturini (1); A. Meunier (1); A. Munk (1)

(1) Sciences Po, médialab, Paris, France

In our contribution we will present the platform Climaps.eu: a digital atlas providing data, visualizations and commentaries about climate adaptation debate.

This atlas is addressed to climate experts (negotiators, NGOs and companies concerned by global warming, journalists...) and engaged citizens. It employs advanced digital methods to deploy the complexity of adaptation discussions and information design to make such complexity legible. Climaps contains 33 issue-maps, each focusing on one adaptation issue and providing:

• an interactive visualization;
• a discussion of the map and the findings that it discloses;
• a description of the protocol through which the map has been created;
• the data on which the map is based and the code employed to treat them.

Climaps.eu has been produced by the EU-funded project EMAPS (www.emapsproject.com) as the largest experiment tempted so far with the method of ‘controversy mapping’. Controversy mapping is a research technique developed in the field of Sciences and Technology Studies to deal with the growing intricacy of socio–technical debates. Instead of mourning such complexity, it aims to equip engaged citizens with tools to navigate through expert disagreement. Instead of lamenting the fragmentation of society, it aims to facilitate the emergence of heterogeneous discussion forums.

A few examples of the Climaps.eu findings that we will discuss in our presentation:

Adaptation and mitigation in the UNFCCC

Analyzing the Earth Negotiation Bulletin, we identified the main discussion in the UNFCCC, traced their visibility over time and the countries engaged with them. Adaptation and mitigation, we concluded, have different places in the UNFCCC. Mitigation constitutes the main object of the convention, is present everywhere in its conversation and structures the articulation of the debate. Adaptation, on the contrary, appears as a group of specific discussions and has a limited though central place in the negotiations. Although, adaptation is present from the beginning in UN conferences (in particular the question of its funding), an ‘adaptation turn’ is visible from 2004 with
the rise of the questions of vulnerability and of climate change impacts.


The geopolitics of adaptation expenditure

Using RioMarkers coding we extracted from the OECD Official Development Assistance the bilateral adaptation funding and visualized it in a way that allows comparing how the distribution of aid varies between these countries. We compared not only the amounts committed by donor countries, but also their preferred policy areas. The concentration of their aid, their favored recipient countries and closest UNFCCC recipient groupings. Some donors appear to specialize in particular policy areas: for example, Japan is best at funding disaster reduction; France water management; Spain government and civil society; UK biodiversity and Germany agriculture. Some countries commit a larger percentage of their aid more among policy areas and recipient countries (EU, Denmark) than others (Spain, Italy, Ireland), which could suggest a more planned approach to adaptation aid.


Who deserve to be funded

We have compared the priorities of bilateral and multilateral adaptation funders with different ways of assessing vulnerability. Using Germanwatch, DARA and Gain vulnerability indices, as well as the Human Development index, we explored possible correlations between the amount of money allocated to a country and the degree to which it could be said to be climate vulnerable. We found both positive and negative correlations. In general, development oriented indices correlate more with adaptation funding, providing evidence that adaptation and development are closely connected. We have also tried to find out, where vulnerability indices are mentioned and we found that climate specific vulnerability indices are rarely used by actors in the UNFCCC process, but widely cited in the new media.

cfr. http://climaps.eu/#/1/narrative/who--deserves-to--be-funded

4419 - Climate science in the public sphere. Media coverage and communication devices analysis for effective policy implementation

ORAL PRESENTATIONS

O-4419-01

Climate change journalism - communicating the science

E. Eide (1); J. Painter (2); R. Kunelius (3)
(1) Akershus University College for Applied Sciences, Department for journalism and media studies, Oslo, Norway; (2) University of Oxford, Reuters school of journalism, Oxford, United Kingdom; (3) School of Social Sciences and Humanities, Tampere, Finland

The MediaClimate network presents the results of TV and newspaper representation of the IPCC AR5 reports in a large number of countries, analyzing the differing levels of attention and frames emerging when journalists in a variety of national contexts report on the latest results from climate scientists. To what extent are the carelessly communicated scientific concepts, such as uncertainty, probability and degrees of likelihood present in the journalistic texts? Which voices are quoted, which genres are salient, and which representations are made by editors and journalists? To what extent are the IPCC results and recommendations related to peoples’ everyday experiences investigated in the media? Which challenges in reporting on a global scientific endeavour may be traced, and what are the perspectives for a more cosmopolitan (globally oriented) journalism?

O-4419-02

Advancing climate mitigation efforts through dialogue with the Australian Public

P. Ashworth (1)
(1) University of Queensland,, School of Social Sciences, Brisbane, Australia

There is no doubt the politicisation of climate change discussions in Australia have severely impacted the coordination of Australia’s mitigation actions. Despite the lack of proactive action at the political level, many of the Australian public are concerned about climate change and its impact, but are at a loss as to what might be the best actions for them to take as part of the response to climate change. To help facilitate greater understanding of the portfolio of mitigation options and raise awareness of actions that can be taken at the individual and community level, a number of engagement and dialogue opportunities have been undertaken. This paper will present the research findings from a range of initiatives that are helping public to engaged with lay publics across Australia. As a result of this work we have been able to inform policy makers of public preferences, bring about a reduction in participant footprints and understand in more detail the Australian public’s preferences for engagement on the topic. Processes used vary from kitchen table discussions, to large group process – of up to 100 people in the room; citizens’ panels and interactive survey tools. The results
generally confirm that the Australian public are concerned about action on climate change, but lack in-depth knowledge on the range of low carbon energy technologies.

O-4419-03

Building a vision for a low carbon society in France with non-violent communication methods, result from the R&DDialogue euroean project

M. Ha Duong (1) ; M. Cherbib (2)
(1) CNRS, CIRED, Nogent sur Marne, France; (2) CIRED (International Research Center on Environment and Development), Nogent sur Marne, France

As organisations and governments working towards the energy transition broaden their focus to include a large spectrum of society, they need processes capable of building deep understanding out of the diverse backgrounds, perspectives, and judgements of their stakeholders. Several countries have initiated large-scale social dialogues on the energy transition, demonstrating the difficulties inherent in implementing a genuine dialogue and integrating it into the democratic process.

This communication presents the results of the R&DDialogue project in France, a research–action to implement dialogue at the regional, the national and local levels using renewed tools to improve the practice of democracy.

O-4419-04

How to rethink the Science-Societies debate about climate change?

P. Maugis (1) ; L. Scotto D’apollonia (2) ; S. Blangy (3)
(1) UMR CEA–CNRS–UVSQ (UMR 8212), IPSL, Laboratoire des sciences du climat et de l’environnement, Gif-sur-Yvette , France; (2) Liderf, Montpellier, France; (3) CEFE-CNRS–UMR 5175, Dynamique des Systèmes socio-écologiques, Montpellier, France

The question of climate change is increasingly drawing consensus among the scientific community. However, there is an obvious and continuous lack of dialog between scientists and stakeholders (institutions and civil society). How can we foster debate on climate issues between academics, decision-makers and the citizens of the World?

Such a dialog is impaired in different ways. We will focus on some of those that are particularly pregnant and will propose some mechanisms to address them. The first one lies in polemics and controversies related to uncertainties in the scientific knowledge and the way they are accounted for and communicated. Pascal Maugis will show how uncertainties should be reported in order to go beyond them and eventually make them an opportunity for enlightened and shared decision making for the management of the risks induced by climate change.

Second, “citizen science” about the climate issues remain isolated, weakly coordinated and for the most part unknown to the general public. Moreover, social demands vary a lot, addressing for example educational issues, adaptation measures or public debates. Because the climatologists who intervene in the public space are at the frontier between science, expertise for territorial policies and political strategies, they bear contradictory constraints. This suggests to strengthen the path towards participatory science: A new form of the «Palaver Tree» (L’Arbres à Palabres in french). Inspired by African tradition, the palaver tree is a meeting place where villagers « freely » share their knowledge and problems. Its modernized form, scientifically enriched by Human and Social Sciences, will be explained.

Finally, participatory citizen expertize and science have met several success. Sylvie Blangy will present one such success story on tourism adaptation in Québec.

This presentation is set-up and facilitated by the PARCS (Participatory Action Research and Citizen Sciences) research working group: a group including 50 scientists and NGO members from diverse research fields. The objective of PARCS is to synchronize various initiatives of the «citizen science» about the local strategies, they bear contradictory constrains. This group is conceived as a field-laboratory to explore new ways to question Science-Society relationships, by putting into synergy all demands and initiatives from citizens and institutions. The «palaver tree» is one of its three research axes.

4419 - POSTER PRESENTATIONS

P-4419-01

Dialogue among stakeholders for climate risk management strategies

E. Aoki (1) ; S. Emori (2) ; T. Kiyoshi (2) ; K. Fukushima (1)
(1) The University of Tokyo, Integrated Research System for Sustainability Science, Tokyo, Japan; (2) National Institute for Environmental Studies, Tsukuba, Japan

Climate risk management in long-term and in global scale is a key topic in this century to achieve global sustainability. Therefore, we need to develop risk management strategy to encounter problems caused by climate change. However, climate risk management is still controversial and complicated issue especially in developing countries. One reason is that there are various issues and stakeholders (SHs) play various roles in the society and relationship among them are very complicated. In order to provide arena of discussion for SHs, it is extremely important to provide appropriate scientific knowledge for all SHs in an easy-to-use manner with an understanding of the actual social context.

“ICCA-RUS”, Integrated Climate - Analysis Risks, Uncertainties and Society, a research project funded by the Ministry of Environment of Japan, in order to deliver scientific findings to SHs and to develop climate risk management strategy for various sectors in Japan. From this project, we organized SH dialogue for communicating and developing a framework of climate risk management. We set two objectives; framing climate risk management problems and understanding SHs’ needs. Framing problems is expected to extract agenda, to develop a framework of relationships among perspectives and values, and to understand key factors to influence on problems. Understanding SHs’ needs is to know these three points: what kinds of information sources they would like to use for judgment, how scientists should deliver information for the society and what they expected scientists and different SHs to do for contributing to the better consequences of climate risk management in the future.

This SH dialogue can contribute to develop global strategy and stimulate comprehensive and active discussion in the society. However, conventional methods of interview and discussion are not effective for uncertainty relationship with SHs and issues. In addition, people are not familiar with expressing their opinions to others in Japan and many Asian countries. People also feel non-experts should not talk about issues. In Asian culture, we need to reform and integrate methods for supporting participants to express their views even in front of experts. Thus, we have designed a triangulation approach for the dialogue and its analysis.

The SH dialogue contains three steps: information sharing from experts and in-depth discussion of the problem. In a group discussion. This step-by-step approach encourage participants to join dialogue actively. We also collected relatively small number of people (4-5 people in a group) in focus group discussion. This helps everyone get opportunity and reason to utter in a group. We chose SHs from those who are involved in global climate talks and related activities. The structure of dialogue is divided in two sections; current perspectives in a semi-structured group interview and long-term strategy in an interactive focus group discussion. In the dialogue, we observed group dynamism become active gradually.

From the dialogue records, we made verbatim transcriptions. We analyzed it by the qualitative research method for understanding key categories or points. To utilize all utterance and to integrate the quantitative research methods, content analysis was also adopted to

ABSTRACT BOOK

International Scientific Conference 7-10 JULY 2015 PARIS, FRANCE

764
transcriptions. We give attention to “real voice” deeply but also to comparison analysis and integration in an easy-to-understand manner. Therefore, we can share findings from a multilateral perspectives.

From these triangulation approach, we discussed key categories and related SHs of climate risk management, like international governance, mechanism of decision-making, communication, future vision and so on.

Multiple research design seems to be an effective way for framing complicated issues and setting agenda from it. This diversity of choices in findings is expected to invigorate discussions in society.

P-4419-02

A linguistic analysis of IPCC Summaries and its coverage in scientific and popular media

R. Barkemeyer (1) ; G. Napolitano, (2) ; S. Dessai (3) ; B. Monge-Sanz, (4) ; BG. Renzi, (5)
(1) Kedge Business School, Bordeaux, France; (2) University of Bonn, Institute for medical biometry, informatics, and epidemiology, Bonn, Germany; (3) University of Leeds, Leeds, United Kingdom; (4) European Centre for Medium-Range Weather Forecasts (ECMWF), Reading, United Kingdom; (5) Rome 3 University, School of education, Rome, Italy

The Intergovernmental Panel on Climate Change (IPCC) Summary for Policymakers (SPM) is the most widely read section of IPCC reports and the main springboard for the communication of its assessment reports. Its findings should be communicated in a way that can be understood by a non-scientific audience. Existing studies have focused on the way in which IPCC probabilistic statements are interpreted, and on the discursive construction of the IPCC in national newspapers, including the influence of grammatical and word choices. We have undertaken a linguistic analysis of SPMs and related scientific and popular media coverage on the launch of each IPCC assessment report from 1990 to 2014. We employ widely-established sentiment analysis tools and readability metrics to explore the extent to which information published by the IPCC differs from the presentation of respective findings in the popular and scientific media within this time-frame. IPCC SPMs clearly stand out in terms of low readability, which has remained relatively constant despite the IPCC’s efforts to consolidate and readjust its communications policy. In contrast, scientific and broadsheet newspaper coverage has become increasingly readable and emotive. Our findings indicate that making SPMs more accessible for non-scientific audiences.

P-4419-03

Young Voices: Developing narratives for engaging young people on climate change

A. Corner (1) ; J. Clarke, (1)
(1) Climate Outreach and Information Network (COIN), Oxford, United Kingdom

Young people are in a unique position as they face the reality of a changing climate: potentially they are best-placed to push for and define the long-term societal response to climate change, yet they are also the most vulnerable to the legacy of decisions made by older generations. Young voices are not prominent in the climate change discourse, and engagement with climate change among this crucial demographic is in many ways limited.

In this presentation, we will report the findings from a series of qualitative ‘narrative workshops’ involving 26 young adults in the UK during May/June 2015. The research found that young people see climate change as a problem for the here and now and respond positively to messages that frame climate change as a contemporary concern rather than a future threat. Extreme weather offers a teachable moment addressing climate change with their peers because of a perception that it comes with a certain stigma and is ‘uncool’, or preachy to do so.

Most participants were either unaware or uninterested in the idea of organised climate change scepticism, suggesting that campaigns to counteract science-based scepticism will not be particularly useful for this audience. Debating solutions – rather than the science – was identified as a much higher priority. Some commonly used climate advocacy phrases (such as ‘2 degrees’ or ‘managing climate risks’) were either unfamiliar or unpopular with the young people we engaged. Participants were receptive to the idea of protecting the ‘things they love’ from climate change, but to avoid trivialising the issue, felt that it was important to always make the link between the ‘everyday’ and the ‘bigger picture’, joining the dots between the personal and the political.

We will present and discuss these and other key findings, and explore the implications for developing narratives to engage young people more effectively in future initiatives.

P-4419-04

Communicating Climate Change to the General Public and Policy Makers

H. Cutting (1)
(1) Climate Nexus, Strategic Communications, San Francisco, California, United States of America

The results of polling surveys, academic literature, and practitioner field work in communications suggest that the work of communicating climate change should be calibrated in a strategic manner against the mindset and experience of audiences, the larger landscape of communications by all voices that construct the public narrative, a clear theory of change, and a clear understanding of the goal of science communicators. Scientists are highly sought after communicators in public discussion on climate change – but that dynamic is driven more by the high regard and trust the public places in scientists when discussing a controversial issue than any public interest in taking a deep dive into the science. Polling in the context of climate change communications is best used as a road map, illustrating audience mindset, not as a compass heading indicating direction of travel. Support for climate protection in the general public is often a mile wide but only an inch deep. One barrier is the impression of climate change as a distant and abstract threat. Extreme weather offers a teachable moment addressing a key misperrceptions regarding climate change. Another issue is the analog of smog that audiences bring to their understanding of carbon pollution. Another compounding problem is the self-identification by the audience of bad actors. The experience of science communications on tobacco control offers a helpful soltution here. Action on climate change requires what sociologists call «hot cognition», a story element that goes beyond the physical science of climate change. Principles for effective climate science communication include: tell us what you know (not what you don’t know) and choose metaphors that not only illustrate the science but highlight the significance of the situation. The bathtub metaphor for carbon sinks and sources is one example of a tecially correct metaphor that often sends the wrong message. Scientists can leverage their validating authority to affirm the basic climate science narrative that speaks to the interests of the general public and policy makers, a narrative that centers on the salience of the science for public policy, not on the physics or chemistry of the science. The narrative is centered on five key points:

- Climate change is happening, right here, right now.
- We’re causing it.
- Scientists agree about this.
- We can fix it.
- We can’t wait, the problem is locking in now.

P-4419-05

Climate Communication: Bringing It All Together

R. McCarthy (1)
(1) Met Office, Exeter, United Kingdom

When it comes to matters of global importance a wide view is needed. This talk brings together independent studies in the fields of communication, media, psychology, linguistics
We discuss the results of a research paper that uses comprehensive firm and plant level data for more than 4,500 French manufacturing firms. It examines the economic and environmental impact of the EU ETS. Our results suggest that ETS regulated manufacturing plants in climate reduced emission recommendations would save 20%, a significant amount. The most marked reduction in emissions occurs following Phase II of the EU ETS in 2005, though the effect of emission reduction actions occurring during Phase I (2005–2007). Further investigation provides evidence that while these emission reductions do not arise from reallocation within the firm there is some evidence that these reductions are, at least in part, the result of outsourcing carbon-intensive production.

We also discuss recent research investigating the relative intensity of knowledge spillovers in clean and dirty technologies. In addition, a recently published paper by one of the co-contributors and his coauthor shows that the ETS has increased low-carbon innovation among regulated firms by as much as 10%, while not crowding out patenting for other technologies.

Together, these provide a robust basis for discussion of the impacts of carbon pricing, on emissions, economic performance and innovation by firms.
O-4420a-02
Assessment of Allowance Mechanism in China's Carbon Trading Pilots
L. Xiong (1)
(1) Wuhan University, Institute for International Studies, Wuhan, Hubei, China

Due to its rapid economic expansion over the last decade, China has become the world’s largest energy consumer and greenhouse gases (GHGs) emitter. With growing resources and environmental constraints domestically and the need for meeting international commitment to GHGs abatement, China’s National Development and Reform Commission (NDRC) launched a series of local carbon cap-and-trade pilots in cities and provinces such as Shenzhen, Beijing, Tianjin, Shanghai, Chongqing, Guangdong, and Hubei, each of which has started its operation between 2013 and 2014.

In this paper, we examine the allowance mechanism of China’s pilots from two aspects, one is the allowance allocation, and the other is the allowance distribution and make comparisons in the two aspects with EU Emissions Trading System (EU ETS) and CA CAT. Allocation determines how the carbon emission cap on the total number of emission allowances is set and how emission allowances are allocated among covered entities within the cap. Allowance distribution deals with distribution of allocated allowances to all covered entities as well as dynamic allowance management in post-distribution.

China’s carbon trading pilots formed its unique allocation mechanism, which includes the following four characteristics: rigid cap combined with elastic structure, historical emissions method combined with benchmarking, free distribution combined with the auction, pre allocation combined with post adjustment. However, due to the short preparation time and lack of sufficient emissions data, there are many problems in the pilot design of the allocation mechanism, such as the loose cap, whipping the fast ox, double counting, and too small proportion of benchmarking and auction.

O-4420a-03
Emission Trading Scheme and competitiveness: the tricky equation of free allocation for the EU ETS through to 2030
E. Alberola (1); M. Jalard (1)
(1) CDC Climat, Research, Paris, France

One of the central debates surrounding the design of the European Emission Trading Scheme is the approach to address carbon leakage concerns. In preparation of its phase 4, new design settings proposals of the European Commission in January 2014 have revived the debate. Based on the approach of European Commission’s communication on the 2030 Energy and Climate Framework, in October 2014, the European Council approved a new target to reduce CO2 emissions by 43% in EU ETS sectors by 2030 in addition to the implementation of a market instrument for stability. These two measures are likely to induce the emergence of a more robust carbon price signal, and the Council committed to the continuation of free allocation for industry after 2020.

From 2005 to 2012, all installations were eligible for free allowances which were allocated using installations’ historical CO2 emissions. Since 2013, free allowances have been allocated according to EU harmonized rules on the basis of benchmarks (carbon intensity target) and historical production levels. These have been adjusted by a coefficient of exposure to the risk of carbon leakage and finally adjusted to the free allocation cap by a Cross Sectoral Correction Factor (CSCF). In this new context, the paper assesses the robustness of the expansion of the 2020 mechanism to define the amount of free allocation by 2030 regarding three criteria. Firstly, free allowances are assumed to mitigate carbon leakage risks efficiently and sustainably; secondly to minimize sectorial distortions; and thirdly to maintain the environmental and economic efficiency.

In a first section, based on a literature review and on estimations from industry data, the paper examines the phase III experiences which provide useful insight into the necessary considerations for phase IV of the EU ETS. Then, in the second section, the paper presents three modeling scenarios to define the amount of free allocation for the European industry: a scenario of the expansion of the 2020 mechanism by 2030, a scenario with the output based mechanism and three alternative scenarios based on the output based mechanism with additional measures to mitigate the uncertainty of an ex-post adjustment.

We conclude that, by extending the current mechanism, the amount of free allowances remains higher than the free allowance cap, which should mechanically decrease from roughly 800 million in 2013 to 500 million by 2030. It would thus be necessary to gradually reduce the amount of freely allocated allowances using a Cross Sectoral Correction Factor (CSCF) from 94% in 2013 to 82% by 2020 and 66% by 2030. The implementation of the output based allocation based on actual industrial production (rather than historical), using up to date benchmarks in line with technological progress, would induce an annual correction coefficient of 71% in 2030. However, depending on the annual aggregate activity level, a new uncertainty would arise concerning the value of the CSCF coefficient. According to our estimates, this coefficient would be comprised between 62% and 82% in 2030, which would imply an uncertainty on the net carbon cost of the magnitude of 10% of the added value in the cement sector and 6% for in the steel sector, under the assumption of a 30€/tCO2 price.

There are three potential avenues which can be explored to mitigate this uncertainty and facilitate investment in low carbon technologies. Firstly, a reserve of free allowances could be established to offset yearly deficit / surplus between free allowances cap and the quantity of freely allocated allowances. Secondly, by removing the free allowance cap, the need to apply the correction factor is eliminated. However, this may reduce the amount of auctioned allowances, which was already decreased by a market stability reserve (MSR). Finally, the definition of a more targeted list of sectors at risk of carbon leakages could reduce the number of free allocations by identifying and gradually allocating allowances according to sectors exposure. This would deem it unnecessary to apply the correction factor, and therefore eliminate all associated uncertainty. The method of dynamic allocation combined with a more targeted list would thus be an adequate solution to the tricky equation of free allocation through to 2030.

O-4420a-04
Energy market regulation and leakage: implications for industry
S. Weishaar (1)
(1) University of Groningen, Law and Economics, Groningen, Netherlands

Electricity markets are crucial for addressing climate change. Electricity generation accounts for vast amounts of greenhouse gas emissions and electricity costs are an important concern for industries and thus a prominent topic in leakage discussions. This contribution focuses on electricity leakage (the avoidance of emission costs when generating electricity through relocation or importation) and its implications for industry. From an economic and a legal analysis it highlights 1) the carbon pricing implications for industry in terms of incentives for innovation and investments and 2) compare different regulatory approaches in various emissions trading systems such as e.g. the EU ETS, RGGI and Korea.

O-4420a-05
Inclusion of Consumption in Carbon Pricing Systems
K. Neuhoff (1)
(1) German Institute for Economic Research (DIW Berlin), Berlin, Germany

Climate protection is a global challenge that all countries have a common but differentiated responsibility to address. The UNFCCC Lima outcome reconfirmed that pricing carbon remains important. However, not all governments are willing to commit to targets of equal stringency. Moreover, many countries may have different views on the choice of policy mix. Some countries may put a stronger emphasis on the carbon price and see a higher
Carbon price in the policy mix whereas other countries may make more use of other regulatory instruments. Carbon prices may thus continue to differ over longer time horizons. Without additional measures, this difference in the carbon price threatens a shift in production volumes to regions with lower carbon prices, which would undermine the effectiveness of carbon pricing.

Carbon leakage protection measures have therefore been and will continue to be taken that complement carbon pricing in the production of carbon intensive materials. As leakage protection measures, all emission trading mechanisms thus offer free allowance allocation and all carbon tax schemes have implemented some exemptions for materials production. As a result, the carbon price signal is largely eliminated for mitigation opportunities in the materials sector other than efficiency improvements within the production process. In our studies of the cement and steel sector we found that only 10 to 20% of emission reduction potential exists through further efficiency improvements. The majority of future mitigation opportunities are linked to breakthrough technologies, the use of higher value products and thus lower weight and carbon intensity, alternative materials and more tailored use of materials. Thus the current carbon leakage protection system is linked to the realization of the majority of mitigation options in these sectors. The reform options for leakage protection currently discussed for the European Union Emissions Trading System (EU ETS), dynamic allocation and abandoning the linear adjustment factor, would further reinforce this effect and undermine incentives for mitigation along the value chain. This puts at risk the low-carbon transformation of our economies because materials production comprises the largest share of industrial emissions.

Hence for post 2020 a new philosophy for leakage protection is necessary. We therefore propose to introduce a scheme (Inclusion of Consumption) for high-carbon commodities that:

1. continues to ensure leakage protection by (benchmark based) free allowance allocation or corresponding tax exemptions
2. includes the domestic consumption of selected carbon intensive materials in carbon pricing schemes.

The scheme, which would replicate systems that are already in place for the consumption of electricity in emission trading mechanisms of Chinese provinces and the Republic of Korea, would thereby restore the carbon price signal for the value chain which is broken where leakage protection motivates free allocation or tax exemptions. Thus the carbon price could contribute to set the incentives necessary for a low-carbon transformation of production and use of carbon intensive commodities.
It is widely assumed in economic studies that the optimal approach to carbon pricing is a single global carbon price, reflecting the ‘social cost of carbon’, which should rise over time to reflect the assume cost or constraint. We first detail the assumptions under which this would be true, and then show (mainly by implication), which is one of the reasons why nothing like this is observed in practice. At the same time, industrial expectations of long-run carbon price trajectory are crucial for long-term investment, so developing a common understanding of desirable contours of carbon prices over space and time is central.

Reasons why a common global carbon price is not welfare-efficient include those articulated by Chichilnisky and Heal in the 1990s, with reference to international inequalities; we add some specific real-world illustrations. We then analyze the reasons why even in an equal world, factors of expectations, inertia, uncertainty and evolutionary economic considerations (including the combination of innovation and infrastructure in different sectors) may all create residual carbon-price effects, which may be larger than the estimated SCC, illustrating with respect to varied published models with different dynamics specifications.

We build upon this work in three ways. First, conceptually, we link some of the existing modelling literature to the framework of economic fundamentals of economic processes in Grubb, Hourcade and Neuhoff (2014), notably the Second and Third domain processes of markets and innovation respectively, and highlight implications in terms of the relationship between these economic processes and corresponding policies. Second, we present results from a simplified model which to illustrate some aggregate influences and potential magnitudes of these effects, comparing results from other aggregate global models.

Finally, we discuss how interactions between the various factors should inform understanding of the desirable ‘contours’ of carbon price development over space and time. In particular we illustrate some implications for the debate on linking emissions trading systems, in terms of the need for exchange rate mechanisms which can help to both achieve equilibrium of inventories and returns, and to help to foster the processes of regional transformations.

O-4420b-02
Price formation in the EU ETS: politics or abatement-related fundamentals? Policy implications
G. Grosjean (1); N. Koch, (2); O. Edenhofer (1); S. Fuss (2)
(1) Potsdam Institute for Climate Impact Research, Potsdam, Germany; (2) Mercator Research Institute on Global Commons and Climate Change (MCC), Resources and international trade, Berlin, Germany

First, we analyze empirically the drivers of the carbon price between 2008 and 2013 in the world’s largest cap-and-trade system – the EU ETS. We provide evidence that the market fundamentals such as the economic crisis, the development of renewables and the use of international carbon credits explain only a small share of price variation during the period.

Secondly, we investigate how and to what extent allowance prices respond to regulatory news. Capitalizing on an event study method that incorporates a highly flexible econometric specification, the news-implied price response to 28 hand-collected announcements about the time profile of EU ETS supply schedules that took place between 2008 and 2014. The induced price reaction gives an instantaneous feedback on how market participants view the evolution of cap stringency in the light of a particular policy announcement. Our findings suggest a high responsiveness of the cap-and-trade system to political news.

Evidence that the backloading decision process caused substantial price declines. The event-induced negative price drifts evolve gradually as market participant’s faith in the political support for backloading is shaken in the light of severe decisional bottlenecks in the lengthy legislative process. In addition, we document positive price drifts. These results point to an underappreciated feature of cap-and-trade programs: with temporarily non-binding periodic cap, market perceptions will dominate price formation. If a relaxation of cap schedules in the future is expected, the current allowance price drop significantly, irrespective of whether the contemplated change actually happens.

Thirdly and following our findings, regulatory instruments to stabilize expectations in the market and induce sufficient investment in low-carbon technologies are required. This includes both price and quantity adjustment mechanisms as well as institutional reform such as delegation to an independent carbon central bank.

O-4420b-03
Extending carbon pricing with the expansion of the ETS scope: the road transport sector moving towards the EU ETS?
E. Alberola (1); P. Coussy (2); P. Portenart (2); M. Afriat (1)
(1) CDC Climat, Research, Paris, France; (2) IFPEN, Economy, Paris, France

One of the central debates surrounding the design of Emissions Trading Scheme is the question of its sectorial scope and its potential progressive expansion. In the context of the increasing development of emissions trading schemes all around the world, and the experience of implemented emissions trading schemes could be useful for other governments which should involve or would like to be involved in the implementation of this carbon policy.

In Europe, the Emissions Trading Scheme (EU ETS) covers energy and industry sectors. However, since 2005, there have been several extensions of the EU ETS: new sectors (domestic aviation) and gases. In the context of the EU ETS reform and in its first report on the EU ETS functioning in November 2012, the European Commissions suggested to constraint Energy and other CO2 future trends in sectors currently outside the EU ETS by for instance including fuel consumption in other sectors. In the 2030 Energy and Climate framework, the European Commission introduced a new sectorial approach, equitable, development of investment in sectors in the coverage such as road transport or buildings sectors. Beyond the overall revision of the EU ETS directive, the road transport sector can be included in the EU ETS via the opt-in provision which gives Member States the option of introducing, voluntarily and unilaterally, new GHG or new sectors. Denmark is the first European State to express, in September 2014, its wish to include the road transport sector in its national Emissions Trading scheme (ETS) target.

Based on this policy context, the paper deals with the introduction of the road transport in the EU ETS. In a first section, the paper analyzes the current situation in terms of emissions from road transport in Europe by 2030 by modeling technology deployment in passenger and heavy duty car parks in two main regions in Europe (EU15 and EU13).

In a second section, the paper investigates what lessons could be drawn for the European Union from the experience of others ETS. Since the implementation of the EU ETS in 2005, other emissions trading schemes have been developed but only a small number include or envisage including road transport in the emissions trading systems. For instance, the New Zealand includes the road transport in 2008 and California and Quebec’s emissions trading schemes cover transport fuels suppliers and importers since 2015. The analysis reveals two main design lessons: in all cases, the emission trading scheme is a complementary measure adding to other sectorial policies and credit offsets play a key role to mitigate compliance costs.

Then, the third section analyses what would be institutional and economic impacts of the introduction of the European road transport in the EU ETS. Based on modeling results from three different general equilibrium models, the paper reveals that the EU road transport sector is not likely to be included in the EU ETS by 2030. First, we conclude that the new burden sharing after the road transport inclusion would be supported mainly by the power sector. Secondly, the CO2 price would increase sharply revealing higher compliance costs without the potential opportunity to use offsets credits. Thirdly, the new higher carbon price with the road transport in the EU ETS would be too low to trigger new structural changes in the sector towards the deployment of low-carbon technologies or behaviors.
ABSTRACT BOOK

PARTNERSHIP, GLOBALLY NETWORKED ETS, etc. can be better/easier to link with. Different linking path analysis of schemes’ design features (whom would it can be remedied. Such relative concepts as linkability determinants and key convening features of past linkages the potential sacrifice from not linking. We identify gained by flipping it upside down and rather addressing Regarding the why-link side of the question, much can be overcome by gradual alignment.

Although on the face of it inter-ETS linkage looks appealing, impediments to linking could arise from these discrepancies. This raises the twofold issue of whether to engage in linkage given the risks and challenges involved; and of how to link up ETSs given such discrepancies and how these could be overcome by gradual alignment.

Regarding the why-link side of the question, much can be gained by flipping it upside down and rather addressing the potential sacrifice from not linking. We identify determinants and key convening features of past linkages and investigate the question of how to make linkage more attractive and induce further cooperation.

On the how-to-link side of the question, we discuss what we identify as impediments to linkage and how these can be remedied. Such relative concepts as linkability or compatibility are discussed in light of a comparative analysis of schemes’ design features (whom would it be best to link with). Different linking path scenarios are then reviewed, namely case-by-case or bilateral regulation, definition of model rules for regional partnership, globally networked ETS, etc.

O-4420b-04

Linked domestic CDM: A proposed climate architecture

K. Pillay (1)
(1) Environmental Resource Management, Sustainability and Climate Change, Johannesburg, Gauteng, South Africa

Three dominant issues have historically plagued climate negotiations: how to bypass issues of sovereignty, generate sufficient climate finance, and establish an agreement that is inclusive of the current major polluters. Despite the highly contested nature of the Clean Development Mechanism (CDM) under the Kyoto Protocol, it provides policy makers with a starting point for the formulation of climate policy architecture. This research proposes the integration of CDM, as hosted by each state and therefore under their jurisdiction, into a linked climate policy architecture. A linked domestic CDM system would allow for Certifiable Emission Reductions to be earned through the implementation of domestic projects or projects hosted in other states. These Certifiable Emission Reductions can act as a unique climate currency for each state. This research questions how a linked domestic CDM system would be structured in a climate finance context, specifically analysing how Certifiable Emission Reductions would operate and interact as a climate currency. From this research, we conclude that fixed exchange rates are more stable than flexible exchange rates in a climate currency framework. Fixed Exchange Rates reduce losses of capital (owing to uncertainty in the markets) and the prominence of asymmetric spatial price transmission associated with flat Certifiable Emission Reductions prices. To encourage cooperation between developing and developed countries, it is recommended that a combination of currency area theories can be implemented as opposed to a currency union. Currency areas are the most viable option as they maintain that the CDM is under the control of the state and retains a level of stability as individual state Certifiable Emission Reductions prices are fixed to the same price. Even though this research forms the basis for a new climate policy architecture, the overall effectiveness of the policy will be determined by the selection of appropriate schemes, intricacies of past and agreement by states, and most significantly, political will.

O-4420b-05


S. Quemin (1); R. Trotignon (2); B. Solier (2)
(1) Centre International de Recherche sur l’Environnement et le Développement, Paris, France
(2) Centre International de Recherche sur l’Environnement et le Développement, Paris, France

This presentation will come after contributions about design and functioning issues of carbon markets in Europe, the U.S. and China.

Following these presentations, it’s appear clearly that the fragmentation of carbon markets in the world is reflected by the wide range of regional designs, among which discrepancies regarding flexibility rules and dynamic price management mechanisms are particularly salient.

The joint analysis of the distributive impacts across sectors, consider various revenue-recycling schemes that better contribute to signal prices, (ii) the response of wages to changes in unemployment, (iii) the effectiveness of alternative mechanisms on public finance management, (iv) the effects of price competitiveness, by observing the response of changes in production costs in France with the rest-of-world, exogenous to the model.

The version of the model is calibrated by data of the year 2010.

The critical point of a carbon tax reform is to contain the spread of a higher energy costs on production costs, increases that ultimately affect the purchasing power of households and affects the international competitiveness of firms.

The model is based on a set of economic parameters on which various beliefs are expressed, and from which we must conduct systematic sensitivity tests: (i) the adjustment of energy consumption levels in response to signal prices, (ii) the response of wages to changes in unemployment, (iii) the effectiveness of alternative mechanisms on public finance management, (iv) the effects of price competitiveness, by observing the response of changes in production costs in France with the rest-of-world, exogenous to the model.

The aim of this presentation is to explore tax arrangements that can help to reduce the negative aspects of the application of carbon tax through objectives comprising equity, competitiveness and better efficiency.

This will be done by comparing the impacts of different strategies on various macroeconomic indicators, and through analysis of the corresponding distributive effects on energy-intensive sectors, as well as on households with different levels of income.

Each strategy offers different options to recycle the carbon tax revenue, in situations when it is applied unilaterally to the French economy.

We use the IMACLIM – France computable general equilibrium model designed for comparative static exercises. It represents an open-French economy, distinguishing four categories of agents (households, businesses, government and «the rest-of-world»). The description of the production system distinguishes the energy sectors, as well as energy-intensive sectors, and a composite remainder of the economy.

IMACLIM is a «hybrid» model. It is based on input–output tables of the national accounts previously harmonized with the energy statistics. It is structured in a consistent framework for the study of environmental issues. This harmonization effort between energy balance and national accounts provides an accurate description of energy volumes traded directly through their physical flow. Furthermore, the distribution of income and the structure of public finances are detailed without disrupting the overall consistency, reconciling the macroeconomic data from household surveys with macroeconomic statistics.

The model is based on a set of economic parameters on which various beliefs are expressed, and from which we must conduct systematic sensitivity tests: (i) the adjustment of energy consumption levels in response to signal prices, (ii) the response of wages to changes in unemployment, (iii) the effectiveness of alternative mechanisms on public finance management, (iv) the effects of price competitiveness, by observing the response of changes in production costs in France with the rest-of-world, exogenous to the model.

The version of the model is calibrated by data of the year 2010.

The critical point of a carbon tax reform is to contain the spread of a higher energy costs on production costs, increases that ultimately affect the purchasing power of households and affects the international competitiveness of firms.

The combination of a carbon tax with structural policies to support growth (lower social contributions) does not reduce the unequal effects of taxes. To reconcile equity, employment and activity level, it seems essential to combine these policies with specific compensation mechanisms according to household income levels, and to the exposure of energy-intensive sectors to international competitiveness.

Thanks to the sectorial and household disaggregation described by the latest version of the model, we consider various revenue-recycling schemes that better preserve altogether economic efficiency, equity and competitiveness.

The joint analysis of the distributive impacts across sectors,
the distributive impacts between households, and their macroeconomic feedbacks on the rest of the economy, and of several environmental policy proposals highlight possible trade-offs for maximizing global consumption, reducing unemployment, reducing inequalities, and protecting exposed sectors.

The analysis framework allows the design of a reform resulting from inevitable trade-offs between redistribution, competitiveness and aggregate impacts on activity and employment.

P-4420-02

How carbon pricing can foster collective solutions

S. Qi (1)
(1) Wuhan University, Economica and Management School, Wuhan, China

China made great decision to reduce its carbon emission based on Cap and trade mechanism. China began its ETS pilots in five cities and two provinces which controls 20 percent of China's carbon emission since 2011 and will start its national carbon market in 2016 based on the experiences of the seven ETS pilots. As the current biggest emitter, China's ambitious action to reduce its emission by market oriented policy will influence our globle emission reduction heavily and will be one of the important driver to getting the international climate agreement in the COP in Paris in this year. Therefore, we will firstly compare the policy features and the effect of the seven ETS pilots in China. Then, we will forecast how to step into a united national carbon market based on the seven ETS pilots. Finally, we will analyse the significance of China's ETS pilots to China, emerging economies and even the globle carbon market and emission reduction.

P-4420-03

«Carbon pricing and markets in the United States: Constructing the new national and international regimes»

J. Wiener (1)
(1) Duke University, Nicholas School of the Environment, Durham, United States of America

This presentation will be part of the Session on «Emissions Trading» as a form of «Collective Action toward Transformative Solutions», featuring several related presentations on the evolving carbon markets in Europe, the United States, and elsewhere, as they build toward an effective and efficient new international regime. This presentation will focus on the United States and Canada. First, it will assess the development of sub-national carbon markets among key US member states, including the «RGGI» emissions trading program among northeastern states and the California emissions trading program, and the links from some of these sub-national programs to carbon markets in other jurisdictions such as Quebec and Ontario, Canada. Second, the presentation will explain the new national program («Clean Power Plan») being advanced by the US Environmental Protection Agency (EPA) under the US Clean Air Act, section 111(d), including its current status (scheduled to be issued in final form during the summer of 2015), its legal basis, its economic efficiency, and the challenges it may face. Third, the presentation will discuss how these North American carbon markets -- especially the EPA 111(d) national «Clean Power Plan» -- may contribute to action at the international level, including the Intended Nationally Determined Contribution (INDC) of the United States along with other countries' INDCs to be presented at COP 21 in Paris in December 2015. It will discuss the potential for linking the evolving carbon markets in the US to those in Europe, China, and others, and it will consider the role of these developing carbon markets in the longer-term evolution of an effective and efficient international climate change regime. Fourth, the presentation will address the development of a carbon price for government policymaking through the US government's «Social Cost of Carbon» (SCC) measure, including the current status of the SCC, ways that governments should periodically revise the SCC, potential improvements to the SCC to encompass a broader array of impacts, and potential diffusion of SCC-type measures around the world. This presentation will draw on the author's prior work in publications such as IPCC 2014, 5th Assessment Report, Working Group III, chapter on «International Cooperation» (of which J.B. Wiener was a co-author); W.A. Pizer et al., «Using and Improving the Social Cost of Carbon,» in Science (5 December 2014) (J.B. Wiener is a co-author); J. B. Wiener, «Property and Prices to Protect the Planet,» in Duke Journal of Comparative & International Law (2009); R.B. Stewart & J.B. Wiener, Reconstructing Climate Policy (2003); J.B. Wiener, «Global Environmental Regulation,» in Yale Law Journal (1999); and the author’s experience helping to negotiate the UN Framework Convention on Climate Change (FCCC) in 1989–92.
## INDEX OF AUTHORS

**A**

<table>
<thead>
<tr>
<th>Author</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Coly</td>
<td>O-2244-04</td>
</tr>
<tr>
<td>A. Kane</td>
<td>O-2244-04</td>
</tr>
<tr>
<td>Aaltonen Hermanni</td>
<td>P-1105-14</td>
</tr>
<tr>
<td>Aarathy, U.I</td>
<td>P-4414-14</td>
</tr>
<tr>
<td>Abba Omar Sabina</td>
<td>P-1113-01</td>
</tr>
<tr>
<td>Abbaris Amara</td>
<td>P-1105-14</td>
</tr>
<tr>
<td>Abbott Benjamin</td>
<td>P-1116-01</td>
</tr>
<tr>
<td>Abbott Kenneth</td>
<td>O-4410-01</td>
</tr>
<tr>
<td>Abdalati Waleed</td>
<td>K-3301-01</td>
</tr>
<tr>
<td>Abdalla Khatab</td>
<td>P-2217-01</td>
</tr>
<tr>
<td>Abdel-Latif Ahmed</td>
<td>O-4413a-02</td>
</tr>
<tr>
<td>Abdel-Rahman Elfath</td>
<td>P-2223-09, P-2229-05</td>
</tr>
<tr>
<td>Abdelgalill Eltigani</td>
<td>P-2222-01</td>
</tr>
<tr>
<td>Abdeljaouad Sâadi</td>
<td>P-1121-02</td>
</tr>
<tr>
<td>Abdoul–Aziz Abebe Abdou Adam</td>
<td>P-3318-01</td>
</tr>
<tr>
<td>Abdoulaye, Diarra</td>
<td>P-3330-82, P-4414-22, P-2222-13</td>
</tr>
<tr>
<td>Abdourhamane Touré Adamou</td>
<td>P-3330-01</td>
</tr>
<tr>
<td>Abel Afouda</td>
<td>P-3330-07, P-2212a-07, P-1117-07</td>
</tr>
<tr>
<td>Abeling Thomas</td>
<td>P-3312-01</td>
</tr>
<tr>
<td>Abi Saab Marie Therese</td>
<td>P-3312-20</td>
</tr>
<tr>
<td>Abidoye Babatunde</td>
<td>P-2223-01</td>
</tr>
<tr>
<td>Ablain, M.</td>
<td>K-1105a-03, P-1107-01, P-1107-02, P-1107-03, P-1107-09</td>
</tr>
<tr>
<td>Aboudarham Jean</td>
<td>P-1105-01</td>
</tr>
<tr>
<td>Abraham Luke</td>
<td>P-1108-02</td>
</tr>
<tr>
<td>Abrar Sandya</td>
<td>O-2235-04</td>
</tr>
<tr>
<td>Abrell Jan</td>
<td>O-2237a-01</td>
</tr>
<tr>
<td>Absar Nilofer</td>
<td>P-2224-23</td>
</tr>
<tr>
<td>Abu Bakar Dayang Ratnasari</td>
<td>P-3315-01</td>
</tr>
<tr>
<td>Achard Frederic</td>
<td>P-2219-05</td>
</tr>
<tr>
<td>Ackerer Philippe</td>
<td>P-2212b-08</td>
</tr>
<tr>
<td>Acma Bulent</td>
<td>P-2229-01</td>
</tr>
<tr>
<td>Acosta Navarro, Juan Acosta</td>
<td>O-1102-03</td>
</tr>
<tr>
<td>Acworth W.</td>
<td>P-3339-01</td>
</tr>
<tr>
<td>Adam Pawloff</td>
<td>O-4417-04</td>
</tr>
<tr>
<td>Addison, Jason</td>
<td>K-1103-01</td>
</tr>
<tr>
<td>Adeaga Olusegun</td>
<td>P-1119-01</td>
</tr>
<tr>
<td>Adedayo Vide</td>
<td>P-2244-04</td>
</tr>
<tr>
<td>Adefisan Elijah</td>
<td>P-1102-01</td>
</tr>
<tr>
<td>Adegoke, Jimmy</td>
<td>O-1116-03</td>
</tr>
<tr>
<td>Adelegan Joseph</td>
<td>O-4411-04, P-3317-01</td>
</tr>
<tr>
<td>Adeniyi, Mojisola</td>
<td>P-1113-08</td>
</tr>
<tr>
<td>Adeoluwa, O.o</td>
<td>P-3318-03</td>
</tr>
<tr>
<td>Adeyemo Remi</td>
<td>P-2240-01</td>
</tr>
<tr>
<td>Adger Neil</td>
<td>P-3321-17</td>
</tr>
<tr>
<td>Adis Dzebo</td>
<td>O-4407-02</td>
</tr>
<tr>
<td>Adjahossou D. Firmin</td>
<td>P-2224-01</td>
</tr>
<tr>
<td>Adjahossou Sédami B.</td>
<td>P-2224-01</td>
</tr>
<tr>
<td>Adjahossou Vidédji Naëssé</td>
<td>P-2224-01</td>
</tr>
<tr>
<td>Admiraal, Annemiek</td>
<td>O-4402b-01</td>
</tr>
<tr>
<td>Adongo Christine</td>
<td>P-3329-01</td>
</tr>
<tr>
<td>Aduramigba, V. O.</td>
<td>P-3318-03</td>
</tr>
<tr>
<td>Aerts Jeroen</td>
<td>O-4408-02, O-3322b-03</td>
</tr>
<tr>
<td>Affholder Francois</td>
<td>O-3330b-01, P-3330-32</td>
</tr>
<tr>
<td>Afif, Charbel</td>
<td>P-1114-08</td>
</tr>
<tr>
<td>Afouda Fulgence</td>
<td>P-1117-50</td>
</tr>
<tr>
<td>Afriat Marion</td>
<td>O-4420b-03</td>
</tr>
<tr>
<td>Agarwala, Meghna</td>
<td>O-2215-02</td>
</tr>
<tr>
<td>Agboola, Julius</td>
<td>O-2203-02</td>
</tr>
<tr>
<td>Agbossou Euloge Kossi</td>
<td>P-3330-02, P-1117-07</td>
</tr>
<tr>
<td>Aggarwal Pramod</td>
<td>O-2235-03</td>
</tr>
<tr>
<td>Agodzo Sampson</td>
<td>P-3330-06</td>
</tr>
<tr>
<td>Ago Expedit Evariste</td>
<td>P-3330-02, P-3330-02</td>
</tr>
<tr>
<td>ÀGueda, Alba</td>
<td>P-2217-21, P-1116-08</td>
</tr>
<tr>
<td>Aguiar, Ana Paula</td>
<td>P-2215-09, P-2236-08</td>
</tr>
</tbody>
</table>
INDEX OF AUTHORS

Aguilar, Lorena (O-3341-05)
Aguilar Arturo (P-2234-04)
Agustina Ratna (P-4415-01)
Aguzzi Jacopo (K-2208-03)
Ahasan Md. Nazmul (P-1117-01)
Ahlgren Erik (P-3322-08)
Ahlström, Anders (P-2217-25)
Ahmad Muzaffar Baharudin (P-1104-01)
Ahman Max (O-3305-06)
Ahmed Essam Hassan Mohamed (P-3329-02, O-3304-01, P-3317-02, P-2212a-01, P-4418-01)
Ahmed Lina Quadir (P-2217-09)
Ahmed Syed (P-1113-20)
Ahn Chun (P-2223-11)
Ahn Suk-Hee (P-1121-01)
Ait–Kaci Ahmed (P-2212b-08)
Aitken, Robert (P-3330-45)
Ajayi Ayodele E. (P-3301-07)
Ajayi V. O. (P-1117-16)
Ajiro Masataka (K-1115-01)
Akande Samuel (P-2225-01)
Akbari Hashem (K-2229-02)
Akccakaya, R (O-4418b-01)
Akvoll Idar (O-3307-03)
Akhand Akm Monowar Hossain (P-3311-01)
Akinbile Christopher (P-2225-01)
Akinwale Akeem Ayofe (P-2243-01)
Akoègninou Akpovi (P-3331-04)
Akponikpê P.b. Irénikatché (P-3330-47)
Al–Amin Abul Quasem (P-4409-01)
Al–Moosawi Lisa (P-2207-03)
Alam Shawkat (O-3332-04)
Alaniz Nashieli (P-2214-06)
Alao Olukayode (O-3314-02)
Alazard–Toux Nathalie (K-4402b-03)
Alberdi, Ernesto (P-1110-02)
Alberini, Anna (P-4409-03)
Alberola Emilie (O-4420a-03, O-4420b-03)
Albrecht Alain (P-3325-02, O-2218-03)
Alcocer, Javier (P-2212a-19)
Alderman Phillip (P-2224-09)
Aldrian Edwin (P-1117-28)
Alekseenko Elena (P-3326-01)
Alexander Lisa (O-1113-01, O-1118b-06)
Alexander Meghan (O-3337-03)
Alexander Michael (O-1117-01)
Alexandrakis G. (P-4409-22)
Alexis Yao N’go (P-1102-12)
Alfaro Andrea (O-1111b-04)
Alfieri Lorenzo (P-2204-14)
Alfred Duker (P-2217-18)
Ali Babiker Imad–Eldin (P-3312-02)
Ali Ibrahim Somayya (P-4415-08)
Ali Khan Mustafa (P-4418-27)
Alia, Ricardo (O-2244-06)
Alkama Romain (P-2217-06)
Allaire Julien (O-4415a-01)
Allan Richard (P-1106-03)
Allard Vincent (P-2224-07)
Alemand Denis (P-2207-02)
Allen, Simon (P-4418-27)
Allenbach Michel (O-1111b-04, P-3342-02)
Allen Myles (O-1118a-01, O-1118a-02, O-1118b-05, O-2245-04, P-4412-07, P-2204-06, K-1114-01, K-1119b-01)
Allia Khedija (P-4414-01)
Allwood Julian (O-3305-04)
INDEX OF AUTHORS

Almeida, Carine (P-1116-09)
Almeida Oriana (P-2240-02, P-2212b-01, P-2240-22)
Alonso–Roldán Maria (O-3325b-02)
Alpizar Francisco (P-3312-03)
Alric B (K-1101-03)
Altchenko Yvan (P-3320-02)
Altenburg Tilman (K-4410-02)
Alvarado, Hector (P-3312-18)
Alvarez–Solas Jorge (O-2242-03)
Alvarez Maria Jimena (O-3327-03)
Alverson Keith (K-3313-02)
Alves, Paula Rayssa Dias (P-1117-29)
Alves Fátima (P-4409-22)
Alvez–Valle, Carlos Mariano (P-2240-02, P-2212b-01)
Alvez Andrei (P-2214-06)
Amadji Guillaume (O-3325b-03)
Amadou Hama (P-3315-02)
Amani Abou (K-1119a-01)
Amann Thorben (O-3307-01 (part1))
Amaral Paula (P-1101-06)
Ambros Pontus (P-1123-12)
Amélineau, François (O-3327-02)
Amerasinghe Niranjali (O-4412-03)
Ami, Dominique (P2209-10)
Amigues Jean Pierre (P-2224-04)
Amit Kumar (P-2215-12, P-2205-01)
Ammoura, Lamia (P-1115-15)
Amorim Marcelo (P-1119-12)
Amory Charles (P-1107-07)
Amoussou Ernest (O-1119b-05, P-3331-04)
Ampe, Christophe (P-1115-15)
Amraoui Nadia (P-2212b-08, P-1119-02)
Amsad Ibrahim Khan Saleem Khan (P-1104-02)
Anandarajah, Gabrial (P-3315-01, P-4402-06)
Anant Parekh (P-1110-06)
Anaya Fatima (P-2225-02)
Anders, Ivonne (P-2203-03)
Anderson Brooke (P-2204-01)
Anderson Kevin (K-3304-01, P-4403-01, P-3306-01, P-2236-02)
Anderson Michael (P-2214-01)
Anderson Tessa Kate (P-4402-07)
Andersson Camilla (O-2205-03)
Andrade Pedro Ribeiro (O-2219-04)
Andrefouet Serge (P-1111-01)
André Jol (O-1104-03)
Andre Lenouo (P-3330-83, P-3330-03)
Andres Cisneros–Montemayor (K-2209-04)
Andres Norina (O-2211-02)
Andres Robert (O-1114-01)
Andriamananjara Andry (P-3325-02)
Andrieu Bruno (P-2224-07)
Andrieu Nadine (O-2225-01)
Anen Thomas (P-3320-01)
Angelsen Arild (K-2219-01, K-2219-02)
Anger Annela (O-3317-04)
Angers Denis (P-2218-05)
Anglada Josep (P-2245-07)
Angles Stéphane (O-3325b-02)
Angot, Guillaume (O-1108-03)
Ann–Kristin Koehler (P-3330-67)
Anthoni Peter (O-2217-02)
Anthony Edward (O-1101-03)
Anthony Edward (P-2210-02)
Antoine Jean–Marc (P-2211-01)
Antoine Pierre (P-1102-07)
Armendariz-Arnez. Cynthia (P-1121-08)
Arnaud F (K-1101-03)
Arnaud Laurent (P-1107-05)
Arnaud Yves (O-2211-05)
Arnell Nigel (K-2202-02)
Arnheth Almut (P-2223-16, P-2217-25, O-2217-02, P-2217-16, P-2217-23, K-2217-01)
Arora Prakher (P-3301-01)
Arora Vivek (P-1116-02)
Arribas Alberto (P-1117-33)
Arroyo-Cabrales Joaquin (P-1101-01)
Arslan Aslihan (P-3328-01, P-2219-04)
Ars Sebastien (P-1105-14)
Artaxo Paulo (P-221501)
Arun Khatri-Chhetri (O-2235-03)
Asaduzzaman Muhammad (P-3341-01)
Asare, R. (P-2225-11)
Asayama Shinichiro (P-3301-08)
Asayama Yumiko (O-3311-02)
Asfaw, Solomon (P-3328-01)
Asfaw, Solomon (P-3328-01)
Ashworth Peta (O-3315-03, O-4419-02)
Aslam.s. M. Ali (P-2225-17)
Aslam Umar (P-1117-26)
Aspe Chantal (P-3326-06)
Assamoi Eric Michel (O-3318-02)
Assiri A. A. (P-3330-20)
Assis, Talita (P-2215-09, P-2236-08)
Assunção Gabriel (P-2240-08)
Atapattu Sumudu (P-2242-04)
Athenasiou Mary (P-3326-05)
**INDEX OF AUTHORS**

<table>
<thead>
<tr>
<th>Name</th>
<th>Code/Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Athayde Simone</td>
<td>P-2238-02</td>
</tr>
<tr>
<td>Atila Vilar De Almeida</td>
<td>P-2240-22</td>
</tr>
<tr>
<td>Atkinson Marlin</td>
<td>O-2207-03</td>
</tr>
<tr>
<td>Atombo Aleya Munyanya</td>
<td>P-1104-03</td>
</tr>
<tr>
<td>Atteridge Aaron</td>
<td>O-3310-01</td>
</tr>
<tr>
<td>Aubert Diane</td>
<td>K-3308-04</td>
</tr>
<tr>
<td>Aubin Marc</td>
<td>P-3330-02</td>
</tr>
<tr>
<td>Aubry-Kientz Méline</td>
<td>O-2215-04</td>
</tr>
<tr>
<td>Aucan J.</td>
<td>O-1111b-03</td>
</tr>
<tr>
<td>Audet, Carol Ann</td>
<td>O-2238-03</td>
</tr>
<tr>
<td>Auffhammer Maximilian</td>
<td>P-2210-01, K-1118a-02</td>
</tr>
<tr>
<td>Augeard Bénédicte</td>
<td>P-2212b-08</td>
</tr>
<tr>
<td>Augusto Cicero</td>
<td>O-2238-04</td>
</tr>
<tr>
<td>Augusto Franco–Garcia</td>
<td>O-1110-05</td>
</tr>
<tr>
<td>Ault, Toby</td>
<td>O-1117-01</td>
</tr>
<tr>
<td>Aumont Olivier</td>
<td>P2209-04, O-2209-01, P2209-01</td>
</tr>
<tr>
<td>Aura Ruth</td>
<td>P-3341-08</td>
</tr>
<tr>
<td>Aurell, Alice</td>
<td>P-2212a-10</td>
</tr>
<tr>
<td>Auvray Cédric</td>
<td>P-3302-01</td>
</tr>
<tr>
<td>Avery Melody</td>
<td>O-3301-02</td>
</tr>
<tr>
<td>Avino Pasquale</td>
<td>P-1121-03</td>
</tr>
<tr>
<td>Avrin Anne–Perrine</td>
<td>P-3303-01</td>
</tr>
<tr>
<td>Awa Achu Walters</td>
<td>P-3311-02</td>
</tr>
<tr>
<td>Awasthi, Kirtiman</td>
<td>P-4418-27</td>
</tr>
<tr>
<td>Awodun Moses Adeyeye</td>
<td>P-3320-03</td>
</tr>
<tr>
<td>Awolala David</td>
<td>P-2204-02</td>
</tr>
<tr>
<td>Axsen Jonn</td>
<td>O-3315-01</td>
</tr>
<tr>
<td>Axsen Jonn</td>
<td>P-2230-01</td>
</tr>
<tr>
<td>Ayal Desalegn Yayeh</td>
<td>P-2238-08</td>
</tr>
<tr>
<td>Ayanfeoluwa Olufemi Emmanuel</td>
<td>P-3318-03</td>
</tr>
<tr>
<td>Ayanlade Sina</td>
<td>P-3330-04, P-2215-02, P-1117-02, P-1113-02</td>
</tr>
<tr>
<td>Aydin, Kerim</td>
<td>P2209-02</td>
</tr>
<tr>
<td>Aydin, Vera</td>
<td>P-3305-16</td>
</tr>
<tr>
<td>Aykut Stefan</td>
<td>O-4411-07</td>
</tr>
<tr>
<td>Ayong Le Kama Alain</td>
<td>P-2202-01</td>
</tr>
<tr>
<td>Ayyappan N</td>
<td>P-2215-08</td>
</tr>
<tr>
<td>Azam Mehdi</td>
<td>P-4407-08</td>
</tr>
<tr>
<td>Azevedo Ines</td>
<td>O-3303-03, O-3303-03, O-3315-04, O-3315-04</td>
</tr>
<tr>
<td>Azorín–Molina, C.</td>
<td>P-1119-19</td>
</tr>
<tr>
<td>Azzoug, Moufok</td>
<td>P-3330-13</td>
</tr>
</tbody>
</table>

**B**

<table>
<thead>
<tr>
<th>Name</th>
<th>Code/Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>B. Diop</td>
<td>P-3330-74</td>
</tr>
<tr>
<td>B. Erasmus</td>
<td>P-3320-10</td>
</tr>
<tr>
<td>Ba Abdramané</td>
<td>P-1117-41</td>
</tr>
<tr>
<td>Baarsch Florent</td>
<td>O-4406b-04</td>
</tr>
<tr>
<td>Babaeian Iman</td>
<td>P-2201-02, P-2245-02</td>
</tr>
<tr>
<td>Babar Zaheer</td>
<td>P-2201-01</td>
</tr>
<tr>
<td>Babatunde Abiodun</td>
<td>P-2217-02, P-1113-08, P-3301-07, P-1113-01</td>
</tr>
<tr>
<td>Bacci Maurizio</td>
<td>P-3330-05</td>
</tr>
<tr>
<td>Baccini Alessandro</td>
<td>O-1114-03, P-2214-01, O-2238-04</td>
</tr>
<tr>
<td>Bacic, Miguel Juan</td>
<td>P-2240-07</td>
</tr>
<tr>
<td>Badeau Vincent</td>
<td>P-2216-08</td>
</tr>
<tr>
<td>Bader, Martin</td>
<td>P-1116-14</td>
</tr>
<tr>
<td>Badiane Sidia Diaouma</td>
<td>P-3313-05, O-2244-04</td>
</tr>
<tr>
<td>Badiane Yacine N.</td>
<td>O-3325b-03</td>
</tr>
<tr>
<td>Badger Srinivas</td>
<td>P-2222-02</td>
</tr>
<tr>
<td>Badmos Biola</td>
<td>P-3330-06</td>
</tr>
<tr>
<td>Bador Margot</td>
<td>O-1113-05, P-1111-01, O-1111a-02, O-L1.5-01</td>
</tr>
<tr>
<td>Badou Djigbo Felicien</td>
<td>P-3330-07</td>
</tr>
<tr>
<td>Bae Deghyo</td>
<td>P-2212a-02</td>
</tr>
<tr>
<td>Baedeker, Carolin</td>
<td>O-3317-05</td>
</tr>
<tr>
<td>Bae Jong-Soo</td>
<td>P-3307-06</td>
</tr>
<tr>
<td>Baethgen, Walter</td>
<td>O-1117-02, K-3311-01</td>
</tr>
</tbody>
</table>
INDEX OF AUTHORS

Bang, Guri (P-4409-36)
Bangalore Mook (K-2234-03, P-3312-25)
Bangamwabo Victor (P-2229-05)
Bangratz Martine (P-3320-06)
Bannink Andre (O-2223-01)
Bansal Kshitij (O-3323-01)
Banse Martin (O-2223-01)
Barange Manuel (K-2209-01)
Barare, Martin (K-3312-01)
Barau Aliyu (P-2217-03)
Barbara Loic (P-1117-03)
Barbeau Christine (P-3320-04)
Barbeau Gérard (P-2224-21)
Barbier Bruno (P-3330-82, P-4414-22, P-2222-13)
Barbieri Alisson (P-4418-02)
Barbier Jessica (P-3330-36, P-3330-48)
Barbier Nicolas (K-2219-03, O-2219-02, P-2219-11)
Barbi Fabiana (P-3311-03)
Barbosa, H. (P-221501)
Barbosa, P. (O-2233-03)
Barbosa Marcelo (O-1119b-02)
Barcellos, Chriovam (P-4418-22, O-4418b-02)
Bard, Edouard (P-1101-06)
Bardy Marion (P-2225-06)
Barkaoui Ahmed (O-2216-03)
Barkemeyer Ralf (P-4419-02)
Barker Ally (P-2219-11)
Barker Greg (O-2232-05)
Barkmann Tim (P-3313-01)
Barnard Romain (P-1116-13)
Barnes Victor Rex (O-2244-02)
Barnett Mandy (P-4407-01)
Barnier Bernard (O-1117-03)
INDEX OF AUTHORS

Baron Christian (K–3330b–01, P–1117–07)
Baronio Alfredo (P–2239–11)
Baron Jill (O–4418a–02)
Barot Sébastien (P–2224–07)
Barral Hélène (P–1107–07)
Barré Pierre (P–1116–05, P–1116–11)
Barrera Juan (K–L3.5–03)
Barreto Renata (P–2212b–02)
Barrière Olivier (P–4409–25, P–4409–17)
Bärring, Lars (P–4418–16)
Barros, Heglaucio (O–4418b–02)
Barros, Vicente (O–2203–01, P–2204–04)
Barry Boubacar (P–3330–38)
Bart Delathouwer (P–1115–05)
Barthe C. (P–1105–03)
Barthes Bernard (P–2218–01)
Barthes Laure (P–1116–13)
Bartlein, Patrick (O–1102–05)
Baruah Surajit (P–1101–02)
Barus Carole (O–1110–05)
Basauri Bryan Elizabeth (P–3312–05)
Bascuñán Luisa (P–3326–08)
Bashir Yusuf Abubakar (P–3328–02)
Bassinot Franck (K–1101–01)
Bastin Didier (P–3331–01)
Bastin Sophie (P–3330–29)
Bastos Ana (O–2245–02)
Basu Jyotish (P–2226–01)
Bataille Christopher (P–4402–01)
Batanova Valentina (O–1103–03)
Bates, John (K–1105a–01)
Bates, Susan (P–1107–08)
Batet, Oscar (P–2217–21, P–1115–02, P–1116–08, P–1123–02)
Bathiany Sebastian (K–1101–02)
Batiebo Joseph (P–1105–07)
Batisa Ayman (P–1123–01, P–2236–01, P–2238–01)
Batjes Niels (O–1105b–04)
Batra Pandora (P–2207–02)
Baubekova Aziza (P–2212b–03)
Baudic, Alexia (P–1115–15)
Baudoin Marie–Ange (P–3312–06, P–4407–01, P–2238–02)
Bauer Nico (O–3306–01, O–3307–01 (part1))
Baumgarten, Andreas (O–2203–03)
Baum Julia (O–4417–07)
Baumstark Lavinia (O–3306–01)
Bauska T.K. (K–L1.1–04)
Baveco Hans (O–2244–01)
Bayer, Anita (P–2217–25, P–2217–16)
Bazaz, Amir (P–2222–11)
Baztan, Juan (P–4417–03)
Beattie Geoff (P–3317–03)
Beaulieu, Claudie (P–1117–13)
Becherini Francesca (P–3305–17)
Bechtold, Peter (P–1108–06)
Becker Mélanie (O–1111b–03, O–1111b–02)
Becker Norbert (O–3321–07)
Beck Silke (K–2239–01)
Becquer Thierry (P–3325–02)
Bedmar Villanueva Ana (P–3311–04)
Bedran, Ana Maria (P–3312–13)
Beekmann Matthias (O–2205–03)
Beer Tom (P–3320–05)
Beery Joshua (P–3315–03)
Beguería, Santiago (O–1102–08)
<table>
<thead>
<tr>
<th>Author</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Begum Jahanara</td>
<td>P-1113-20</td>
</tr>
<tr>
<td>Beig G</td>
<td>O-1121-04</td>
</tr>
<tr>
<td>Beijia Huang</td>
<td>P-3311-05</td>
</tr>
<tr>
<td>Beisheim Marianne</td>
<td>O-4410-01</td>
</tr>
<tr>
<td>Belikov, Dmitry A</td>
<td>K-1115-01</td>
</tr>
<tr>
<td>Béline Fabrice</td>
<td>P-2218-05</td>
</tr>
<tr>
<td>Bellard C.</td>
<td>K-L2.4-05</td>
</tr>
<tr>
<td>Bellassen Valentin</td>
<td>P-4409-35, P-4409-34</td>
</tr>
<tr>
<td>Belle, E.</td>
<td>P-2214-08</td>
</tr>
<tr>
<td>Bell Justine</td>
<td>P-2243-03</td>
</tr>
<tr>
<td>Bell Michael</td>
<td>P-4418-06</td>
</tr>
<tr>
<td>Bellocci Gianni</td>
<td>K-2223-02</td>
</tr>
<tr>
<td>Bellocq François-Xavier</td>
<td>O-4406a-02</td>
</tr>
<tr>
<td>Bellprat Omar</td>
<td>O-1118b-02, P-1118-01</td>
</tr>
<tr>
<td>Bellucci, Alessio</td>
<td>P-4418-11</td>
</tr>
<tr>
<td>Belotti, Federico</td>
<td>P-3328-01</td>
</tr>
<tr>
<td>Beltrão Norma Ely Santos</td>
<td>P-2214-16, P-2215-05, P-2214-15</td>
</tr>
<tr>
<td>Ben Abdelmalek Maroua</td>
<td>P-3326-02</td>
</tr>
<tr>
<td>Ben Katra Nabil</td>
<td>P-4418-03</td>
</tr>
<tr>
<td>Ben Moussa Thouraya</td>
<td>P-1121-02</td>
</tr>
<tr>
<td>Benavente David</td>
<td>P-1115-01</td>
</tr>
<tr>
<td>Benavides Carlos</td>
<td>P-2236-07, P-3335-01</td>
</tr>
<tr>
<td>Benavides Mar</td>
<td>P-1111-02</td>
</tr>
<tr>
<td>Benazzouz Aissa</td>
<td>P-1110-01</td>
</tr>
<tr>
<td>Bend–Daoud Mohamed</td>
<td>P-1117-27</td>
</tr>
<tr>
<td>Benedetti Marc</td>
<td>P-1119-04</td>
</tr>
<tr>
<td>Beniamino Russo</td>
<td>P-2234-03</td>
</tr>
<tr>
<td>Beniston Martin</td>
<td>K-2211-01</td>
</tr>
<tr>
<td>Benjamin Caryl</td>
<td>P2209-07</td>
</tr>
<tr>
<td>Benjamin Kouassi</td>
<td>P-3330-09, P-1117-51</td>
</tr>
<tr>
<td>Benjamin Sultan</td>
<td>K-3330b-01</td>
</tr>
<tr>
<td>Bennett, Victoria</td>
<td>P-4418-16</td>
</tr>
<tr>
<td>Benoit Marc</td>
<td>P-2218-05</td>
</tr>
<tr>
<td>Benoit Mayer</td>
<td>O-2242-01</td>
</tr>
<tr>
<td>Benson S.</td>
<td>K-L3.2-01</td>
</tr>
<tr>
<td>Bentham Michelle</td>
<td>O-3307-03</td>
</tr>
<tr>
<td>Benveniste, Jérome</td>
<td>P-1107-01</td>
</tr>
<tr>
<td>Benzler Justus</td>
<td>O-1111a-01</td>
</tr>
<tr>
<td>Bera Kartic</td>
<td>P-2224-02</td>
</tr>
<tr>
<td>Berbery Ernesto Hugo</td>
<td>P-1117-04</td>
</tr>
<tr>
<td>Bercu Igor</td>
<td>P-1102-18</td>
</tr>
<tr>
<td>Berenblyum Roman</td>
<td>O-3307-03</td>
</tr>
<tr>
<td>Bergaoui, K</td>
<td>O-1118b-05</td>
</tr>
<tr>
<td>Berger Andre</td>
<td>P-3302-02</td>
</tr>
<tr>
<td>Berger Loic</td>
<td>P-2204-03</td>
</tr>
<tr>
<td>Bergmann, Matthias</td>
<td>P-4418-28</td>
</tr>
<tr>
<td>Berkhout Frans</td>
<td>K-2212b-01</td>
</tr>
<tr>
<td>Berman–Franck Ilana</td>
<td>P-1111-14</td>
</tr>
<tr>
<td>Berman Rachel</td>
<td>P-2217-04, K-2217-01</td>
</tr>
<tr>
<td>Bernadette Nka Nnomo</td>
<td>O-3330a-02</td>
</tr>
<tr>
<td>Bernal Juan Pablo</td>
<td>P-1119-03</td>
</tr>
<tr>
<td>Bernardi Adriana</td>
<td>P-3305-17</td>
</tr>
<tr>
<td>Bernardie Séverine</td>
<td>P-2211-01</td>
</tr>
<tr>
<td>Bernard Laetitia</td>
<td>P-3325-02</td>
</tr>
<tr>
<td>Bernier Quinn</td>
<td>P-3341-02</td>
</tr>
<tr>
<td>Bernoux Martial</td>
<td>O-3325b-03, P-3325-02, P-2218-01</td>
</tr>
<tr>
<td>Berntsen Terje</td>
<td>P-1114-10</td>
</tr>
<tr>
<td>Berrang–Ford Lea</td>
<td>O-3312-01</td>
</tr>
<tr>
<td>Berrios Adolfo</td>
<td>P-3326-08</td>
</tr>
<tr>
<td>Berry Audrey</td>
<td>P-4413-01</td>
</tr>
<tr>
<td>Berry Helen</td>
<td>P-4414-02, O-3325a-01</td>
</tr>
<tr>
<td>Berthelot Hugo</td>
<td>P-1111-04, P-1111-02</td>
</tr>
<tr>
<td>Berthold, Helene</td>
<td>O-2203-03</td>
</tr>
<tr>
<td>Berthon V</td>
<td>K-1101-03</td>
</tr>
<tr>
<td>Berthoud Francoise</td>
<td>P-3305-12</td>
</tr>
<tr>
<td>Author Name</td>
<td>Code(s)</td>
</tr>
<tr>
<td>--------------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>Bertoldo, Raquel</td>
<td>P-2240-04</td>
</tr>
<tr>
<td>Bertolin Chiara</td>
<td>P-2231-01, O-2231-10</td>
</tr>
<tr>
<td>Bertram Christoph</td>
<td>P-4402-02, O-4402a-01</td>
</tr>
<tr>
<td>Besancenot Jean-Pierre</td>
<td>P-1121-09</td>
</tr>
<tr>
<td>Besnard, Simon</td>
<td>P-2219-05</td>
</tr>
<tr>
<td>Bessagnet, Bertrand</td>
<td>O-1121-02</td>
</tr>
<tr>
<td>Bessems Ilse</td>
<td>P-3329-04</td>
</tr>
<tr>
<td>Bessières Laurent</td>
<td>O-1117-03</td>
</tr>
<tr>
<td>Besson, Pascale</td>
<td>P-1103-03</td>
</tr>
<tr>
<td>Besson François</td>
<td>P-2212b-08</td>
</tr>
<tr>
<td>Best, Dennis</td>
<td>P-3306-03</td>
</tr>
<tr>
<td>Betsill Michele</td>
<td>K-4409a-03</td>
</tr>
<tr>
<td>Bettini Giovanni</td>
<td>P-2242-04</td>
</tr>
<tr>
<td>Bettolli, M L</td>
<td>O-1113-10</td>
</tr>
<tr>
<td>Betts Richard</td>
<td>P-2204-10, O-2245-04</td>
</tr>
<tr>
<td>Beuchle, René</td>
<td>P-2219-05</td>
</tr>
<tr>
<td>Beye Assane</td>
<td>O-3312-03</td>
</tr>
<tr>
<td>Beyerl Katharina</td>
<td>P-3301-02</td>
</tr>
<tr>
<td>Bhandari, Sanjaya</td>
<td>P-1117-11, P-2214-02</td>
</tr>
<tr>
<td>Bhatasara Sandra</td>
<td>P-3311-06</td>
</tr>
<tr>
<td>Bhat Nagaraj</td>
<td>P-1117-05</td>
</tr>
<tr>
<td>Bhattarai Dilli Ram</td>
<td>P-2211-02</td>
</tr>
<tr>
<td>Bhuju, Dinesh Raj</td>
<td>P-1117-11, P-2214-02, P-1117-19</td>
</tr>
<tr>
<td>Biasutti Michela</td>
<td>K-3330b-01</td>
</tr>
<tr>
<td>Biasutti Michela K-3330a-02</td>
<td></td>
</tr>
<tr>
<td>Bibas Ruben</td>
<td>P-4402-03, P-3322-01</td>
</tr>
<tr>
<td>Bicheron Patrice</td>
<td>P-2219-11</td>
</tr>
<tr>
<td>Bickford, D.</td>
<td>O-4418b-01</td>
</tr>
<tr>
<td>Biebow Nicole</td>
<td>K-3327-01</td>
</tr>
<tr>
<td>Biegela Isabelle</td>
<td>P-1111-14</td>
</tr>
<tr>
<td>Bienvenu Sambou</td>
<td>P-2216-04, P-2244-01</td>
</tr>
<tr>
<td>Bierkandt Robert</td>
<td>P-2210-01, O-2237a-03</td>
</tr>
<tr>
<td>Biesbroek Robbert</td>
<td>O-3312-01</td>
</tr>
<tr>
<td>Biewald Anne</td>
<td>P-2217-13, P-2219-13, P-2218-06</td>
</tr>
<tr>
<td>Bigano Andrea</td>
<td>P-4409-03, P-4415-05</td>
</tr>
<tr>
<td>Biggs Harry</td>
<td>O-4414-03</td>
</tr>
<tr>
<td>Bigot Sylvain</td>
<td>P-2215-10, P-3330-10</td>
</tr>
<tr>
<td>Bihari Zita</td>
<td>P-1113-10</td>
</tr>
<tr>
<td>Bilan Le Poudec, Anne-Claire</td>
<td>O-3327-02</td>
</tr>
<tr>
<td>Bilegsaikhan Sumiya</td>
<td>P-2242-01</td>
</tr>
<tr>
<td>Bilgera Princess Hope</td>
<td>P-1119-05</td>
</tr>
<tr>
<td>Bilgo Ablassé</td>
<td>O-3325b-03</td>
</tr>
<tr>
<td>Biondi Riccardo</td>
<td>P-1105-18</td>
</tr>
<tr>
<td>Bioret Frédéric</td>
<td>P-2210-06</td>
</tr>
<tr>
<td>Birkeland Nina M</td>
<td>O-2242-08</td>
</tr>
<tr>
<td>Birkmann Joern</td>
<td>O-2203-02, P-2204-15, P-2236-09</td>
</tr>
<tr>
<td>Birol, Florence</td>
<td>P-1110-04</td>
</tr>
<tr>
<td>Bishop, Pamela</td>
<td>O-4418a-02</td>
</tr>
<tr>
<td>Bishwokarma Dipak</td>
<td>P-3311-07</td>
</tr>
<tr>
<td>Bista Raghu Bir</td>
<td>P-1102-02</td>
</tr>
<tr>
<td>Bittner Michael</td>
<td>P-1108-08</td>
</tr>
<tr>
<td>Björck, Svante</td>
<td>O-1110-05</td>
</tr>
<tr>
<td>Bk Nirmal Kumar</td>
<td>P-2216-01</td>
</tr>
<tr>
<td>Black Mitchell</td>
<td>O-1118a-01, O-1118b-06</td>
</tr>
<tr>
<td>Blackstock Jason</td>
<td>P-3321-17</td>
</tr>
<tr>
<td>Blagojevic Dragan</td>
<td>P-1117-24</td>
</tr>
<tr>
<td>Blain Anais</td>
<td>P-3317-04</td>
</tr>
<tr>
<td>Blain Stephane</td>
<td>P-1111-03</td>
</tr>
<tr>
<td>Blanc–Coutagne Eugénie</td>
<td>K-2212b-03</td>
</tr>
<tr>
<td>Blanc Elisabeth</td>
<td>P-1105-03, P-1108-01</td>
</tr>
<tr>
<td>Blanchard Odile</td>
<td>O-4401-03</td>
</tr>
<tr>
<td>Blanchart Eric</td>
<td>O-3325b-03, P-3325-02</td>
</tr>
<tr>
<td>Blanche manche Philippe</td>
<td>O-1119b-03</td>
</tr>
<tr>
<td>Blanc Lilian</td>
<td>O-2215-01</td>
</tr>
<tr>
<td>Blanc Nathalie</td>
<td>K-4410-03</td>
</tr>
<tr>
<td>Blanco–Wells Gustavo</td>
<td>P-3335-02</td>
</tr>
<tr>
<td>Author Name</td>
<td>Reference Code</td>
</tr>
<tr>
<td>------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Blanco Maria</td>
<td>P-2223-17</td>
</tr>
<tr>
<td>Blanc Pierre-Eric</td>
<td>P-1115-03</td>
</tr>
<tr>
<td>Blangy Sylvie</td>
<td>O-4419-04</td>
</tr>
<tr>
<td>Blankinship Joseph</td>
<td>P-1116-13</td>
</tr>
<tr>
<td>Blay–Palmer, Alison</td>
<td>O-4417-03, P-2225-19</td>
</tr>
<tr>
<td>Blesl Markus</td>
<td>P-3303-02</td>
</tr>
<tr>
<td>Blierfriech Jan</td>
<td>P-1104-04</td>
</tr>
<tr>
<td>Bliss Max</td>
<td>P-2240-05</td>
</tr>
<tr>
<td>Blocher Julia</td>
<td>O-2242-02</td>
</tr>
<tr>
<td>Blok Kornelis</td>
<td>O-4412-01</td>
</tr>
<tr>
<td>Blok Vincent</td>
<td>O-2225-02</td>
</tr>
<tr>
<td>Blumenthal Benno</td>
<td>P-4418-06</td>
</tr>
<tr>
<td>Blyth Eleanor</td>
<td>O-2244-01</td>
</tr>
<tr>
<td>Boakye Emmanuel Amoah</td>
<td>O-2244-02</td>
</tr>
<tr>
<td>Boateng Kyereh</td>
<td>P-2216-04</td>
</tr>
<tr>
<td>Bochkarev Nikita</td>
<td>P-2242-08</td>
</tr>
<tr>
<td>Bockel Louis</td>
<td>O-3325b-03</td>
</tr>
<tr>
<td>Bocqueho, Geraldine</td>
<td>P-2215-07</td>
</tr>
<tr>
<td>Bodeker Greg</td>
<td>P-1105-02</td>
</tr>
<tr>
<td>Boden T.</td>
<td>O-1114-01</td>
</tr>
<tr>
<td>Bodian, Ansoumana</td>
<td>P-3330-19</td>
</tr>
<tr>
<td>Bodin, Blaise</td>
<td>P-2214-14, P-2215-07</td>
</tr>
<tr>
<td>Bodin Thomas</td>
<td>P-1107-04</td>
</tr>
<tr>
<td>Bodirsky Benjamin</td>
<td>P-2217-13, P-2219-13, P-2218-06</td>
</tr>
<tr>
<td>Boé Julien</td>
<td>O-1113-05, P-2205-02, P-3330-56</td>
</tr>
<tr>
<td>Bo Elberling</td>
<td>P-1116-17</td>
</tr>
<tr>
<td>Boening Claus</td>
<td>P-1111-08</td>
</tr>
<tr>
<td>Boetsch Gilles</td>
<td>O-3331-02</td>
</tr>
<tr>
<td>Boeuf Marc</td>
<td>P-3302-01</td>
</tr>
<tr>
<td>Bogale Girmaw</td>
<td>P-2212a-04</td>
</tr>
<tr>
<td>Böhm Gisela</td>
<td>O-2240-04</td>
</tr>
<tr>
<td>Boiffin Juliette</td>
<td>P-2216-08</td>
</tr>
<tr>
<td>Boillat Sébastien</td>
<td>O-2218-02</td>
</tr>
<tr>
<td>Bois Benjamin</td>
<td>P-2224-21</td>
</tr>
<tr>
<td>Boissard C.</td>
<td>O-3326-03</td>
</tr>
<tr>
<td>Boissonnade, Auguste</td>
<td>P-2233-03</td>
</tr>
<tr>
<td>Boit Alice</td>
<td>O-2244-01</td>
</tr>
<tr>
<td>Bojovic, Dragana</td>
<td>P-2220-01</td>
</tr>
<tr>
<td>Bokelo, Didier</td>
<td>P-2214-14, P-2215-07</td>
</tr>
<tr>
<td>Boko Michel</td>
<td>O-1119b-05, P-3331-04</td>
</tr>
<tr>
<td>Boko Nadege</td>
<td>P-3325-01</td>
</tr>
<tr>
<td>Bollin Christina</td>
<td>P-4418-04</td>
</tr>
<tr>
<td>Bologo-traoré Maimouna</td>
<td>P-3330-82</td>
</tr>
<tr>
<td>Bolton, John</td>
<td>O-1116-03</td>
</tr>
<tr>
<td>Bonal, Damien</td>
<td>P-1115-06</td>
</tr>
<tr>
<td>Bona Pierre</td>
<td>P-2210-06</td>
</tr>
<tr>
<td>Bonasoni, Paolo</td>
<td>O-1115-05</td>
</tr>
<tr>
<td>Bondeau Alberte</td>
<td>O-2217-02, O-3326-04</td>
</tr>
<tr>
<td>Bonhomme Marion</td>
<td>P-4415-07</td>
</tr>
<tr>
<td>Bonin, Bernard</td>
<td>P-3303-03</td>
</tr>
<tr>
<td>Boniol Mathieu</td>
<td>K-2226-02</td>
</tr>
<tr>
<td>Bonnefond Mathieu</td>
<td>P-3312-09</td>
</tr>
<tr>
<td>Bonnet Sophie</td>
<td>P-1111-04, P-1111-05, P-1111-02</td>
</tr>
<tr>
<td>Bonnet Sophie</td>
<td>P-1111-14</td>
</tr>
<tr>
<td>Bonnin Xavier</td>
<td>P-1105-01</td>
</tr>
<tr>
<td>Bonsang, Bernard</td>
<td>P-1115-15</td>
</tr>
<tr>
<td>Bonsch Markus</td>
<td>P-2219-13, P-2218-06</td>
</tr>
<tr>
<td>Bontemps Jean–Daniel</td>
<td>O-2216-03, K-2218-03</td>
</tr>
<tr>
<td>Bony Sandrine</td>
<td>O-2202-03, P-3330-29</td>
</tr>
<tr>
<td>Bonzanigo Laura</td>
<td>P-3312-20</td>
</tr>
<tr>
<td>Boomsma, Christine</td>
<td>P-3316-05</td>
</tr>
<tr>
<td>Boone, Aaron</td>
<td>P-3330-33, K-3330a-03</td>
</tr>
<tr>
<td>Boonman, Thanonphat</td>
<td>P-3305-06</td>
</tr>
<tr>
<td>Boote Kenneth</td>
<td>O-2223-02, P-2223-07</td>
</tr>
<tr>
<td>Booth, Ben</td>
<td>P-3330-68</td>
</tr>
<tr>
<td>Bop Mamadou</td>
<td>P-3320-09</td>
</tr>
<tr>
<td>Author Name</td>
<td>Code(s)</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>Bousquet-Mélou A.</td>
<td>(O-3326–03)</td>
</tr>
<tr>
<td>Bousquet Philippe</td>
<td>(P-1114–02, P-1114–11)</td>
</tr>
<tr>
<td>Bout-Roumazeilles Viviane</td>
<td>(P-1102–10)</td>
</tr>
<tr>
<td>Bouvet Alexandre</td>
<td>(P-2219–09)</td>
</tr>
<tr>
<td>Bouzou Moussa Ibrahim</td>
<td>(P-3330–65, P-3330–30)</td>
</tr>
<tr>
<td>Bowen Zhao</td>
<td>(O-1108–04)</td>
</tr>
<tr>
<td>Bowery Andy</td>
<td>(O-1118a–02)</td>
</tr>
<tr>
<td>Bows–Larkin Alice</td>
<td>(K-2204–01, P-2203–01, P-2236–02)</td>
</tr>
<tr>
<td>Box, Jason</td>
<td>(O-1110–03)</td>
</tr>
<tr>
<td>Boyd, James</td>
<td>(O-1118a–02)</td>
</tr>
<tr>
<td>Boyd Emily</td>
<td>(O-3324–04, O-3324–01)</td>
</tr>
<tr>
<td>Boye Marie</td>
<td>(P-3302–01)</td>
</tr>
<tr>
<td>Brach, Rosvel</td>
<td>(O-1116–14)</td>
</tr>
<tr>
<td>Braconnot Pascale</td>
<td>(P-2202–03, P-3330–29, P-1119–18, K-1102–03, K-1101–01)</td>
</tr>
<tr>
<td>Bradley Raymond</td>
<td>(P-1101–05)</td>
</tr>
<tr>
<td>Braesicke Peter</td>
<td>(P-1108–02)</td>
</tr>
<tr>
<td>Brama Koné</td>
<td>(P-3328–19)</td>
</tr>
<tr>
<td>Brana–Varela, Josefina</td>
<td>(P-2218–10)</td>
</tr>
<tr>
<td>Brandl, Hannes</td>
<td>(O-2231–06)</td>
</tr>
<tr>
<td>Branger Flora</td>
<td>(K-2212b–03)</td>
</tr>
<tr>
<td>Branković, Čedo</td>
<td>(P-1113–12)</td>
</tr>
<tr>
<td>Branzuela Nympha</td>
<td>(P-3312–07)</td>
</tr>
<tr>
<td>Brara Rita</td>
<td>(P-3323–01)</td>
</tr>
<tr>
<td>Braud Isabelle</td>
<td>(K-2212b–03)</td>
</tr>
<tr>
<td>Breda Nathalie</td>
<td>(P-2224–03, P-2224–04)</td>
</tr>
<tr>
<td>Bréda Nathalie</td>
<td>(O-2216–08)</td>
</tr>
<tr>
<td>Bredariol Tomas</td>
<td>(O-3304–03)</td>
</tr>
<tr>
<td>Breil, Margarethta</td>
<td>(P-4415–05)</td>
</tr>
<tr>
<td>Bremond Laurent</td>
<td>(O-2222–02, P-2215–06)</td>
</tr>
<tr>
<td>Brenninkmeijer Carl</td>
<td>(P-1105–19)</td>
</tr>
<tr>
<td>Breon Francois–Marie</td>
<td>(P-3303–11, P-3302–02, P-2205–09, P-3303–03)</td>
</tr>
<tr>
<td>Bréon François–Marie</td>
<td>(P-1115–15)</td>
</tr>
<tr>
<td>Bousquet–Philippe</td>
<td>(P-1114–02, P-1114–11)</td>
</tr>
<tr>
<td>Bouts–Larkin Alice</td>
<td>(K-3304–01, P-4403–01, P-2236–02)</td>
</tr>
<tr>
<td>Box, Jason</td>
<td>(O-1110–03)</td>
</tr>
<tr>
<td>Boyd, James</td>
<td>(O-4418a–02)</td>
</tr>
<tr>
<td>Boyd Emily</td>
<td>(O-3324–04, O-3324–01)</td>
</tr>
<tr>
<td>Boye Marie</td>
<td>(P-3302–01)</td>
</tr>
<tr>
<td>Brach, Rosvel</td>
<td>(P-1116–14)</td>
</tr>
<tr>
<td>Braconnot Pascale</td>
<td>(O-2202–03, P-3330–29, P-1119–18, K-1102–03, K-1101–01)</td>
</tr>
<tr>
<td>Bradley Raymond</td>
<td>(P-1101–05)</td>
</tr>
<tr>
<td>Braesicke Peter</td>
<td>(P-1108–02)</td>
</tr>
<tr>
<td>Brama Koné</td>
<td>(P-3328–19)</td>
</tr>
<tr>
<td>Brana–Varela, Josefina</td>
<td>(P-2218–10)</td>
</tr>
<tr>
<td>Brandl, Hannes</td>
<td>(O-2231–06)</td>
</tr>
<tr>
<td>Branger Flora</td>
<td>(K-2212b–03)</td>
</tr>
<tr>
<td>Branković, Čedo</td>
<td>(P-1113–12)</td>
</tr>
<tr>
<td>Branzuela Nympha</td>
<td>(P-3312–07)</td>
</tr>
<tr>
<td>Brara Rita</td>
<td>(P-3323–01)</td>
</tr>
<tr>
<td>Braud Isabelle</td>
<td>(K-2212b–03)</td>
</tr>
<tr>
<td>Breda Nathalie</td>
<td>(P-2224–03, P-2224–04)</td>
</tr>
<tr>
<td>Bréda Nathalie</td>
<td>(O-2216–08)</td>
</tr>
<tr>
<td>Bredariol Tomas</td>
<td>(O-3304–03)</td>
</tr>
<tr>
<td>Breil, Margarethta</td>
<td>(P-4415–05)</td>
</tr>
<tr>
<td>Bremond Laurent</td>
<td>(O-2222–02, P-2215–06)</td>
</tr>
<tr>
<td>Brenninkmeijer Carl</td>
<td>(P-1105–19)</td>
</tr>
<tr>
<td>Breon Francois–Marie</td>
<td>(P-3303–11, P-3302–02, P-2205–09, P-3303–03)</td>
</tr>
<tr>
<td>Bréon François–Marie</td>
<td>(P-1115–15)</td>
</tr>
</tbody>
</table>
INDEX OF AUTHORS

Brown Iain (P-2217-05)
Brown Jamie (P-1116-13)
Brugidou Christophe (P-3320-06)
Bruhwiler, Lori M. P. (O-1114-04, P-1114-11)
Brune De Bruin Wandi (O-2240-02)
Brümmer, Christian (P-2235-01)
Brunel Stephanie (P-3330-12)
Brunelle Thierry (P-2223-02, P-2236-05)
Brun Eric (P-1107-15)
Brunet Philippe (K-2232-01)
Brun Jean–François (K-2212b-03)
Brunner Dominik (P-1114-01)
Brunner Lukas (P-1105-18)
Bruno Lidon2 (P-3330-16)
Brunstein Daniel (P-2211-05)
Buckle Simon (K-3309-02)
Budolfson, Mark (P-3322-03, K-4412-01)
Buenvenida Harold (P-2238-03)
Buffet Christophe (K-2239-02)
Bugayong Leonida (P-2219-01)
Buhl, Johannes (O-3317-05)
Bukovsky Melissa (K-1104-01)
Bukvic Anamaria (P-2243-04)
Bunce Anna (K-3341-01)
Bunker Aditi (P-1117-06)
Bunn Christian (P-2225-11)
Büntgen, Ulf (O-1103-02)
Büntgen Ulf (O-2241-05)
Burban Benoit (P-1115-03)
Burch Sarah (O-4415b-04)
Burckel, Pierre (O-1102-09)
Burgess, N. (P-2214-08)
Burgos Ariadna (P-4418-05)

Bressan Barbara (P-4402-04)
Bressan D. (P-1101-04)
Bretagne Geneviève (P-4415-07)
Bretagnon Marine (O-1110-05)
Brewer Thomas (P-4409-04)
Briche, Elodie (P-2212a-22)
Breis François (P-3303-04)
Brierley, Christopher (P-1101-03)
Briggs, David (P-2204-07)
Briggs Stephen (K-1105a-01)
Brigitte Bastide Burkina Faso (P-3330-72)
Brignon, Jean–Marc (O-1121-02)
Briguglio Lino Pasquale (O-3321-06)
Bril Andrey (K-1115-01)
Brimblecombe, Peter (O-2231-07)
Brimblecombe Peter (O-2231-02)
Brinkmann, Carina (P-4418-28)
Brinkop Sabine (O-1108-05)
Briolant Sébastien (O-2226-02)
Brisset Elodie (O-1101-03)
Brito, J. F. (P-221501)
Brizi Leonardo (O-2231-03)
Brockhaus Maria (K-2219-01, K-2219-02)
Broderick John (P-3306-01)
Brognez C. (P-1105-03)
Brook, Barry (P-3302-02)
Brookshaw Anca (P-1117-33)
Broquet, Grégoire (P-1115-15)
Brossard Michel (O-3325b-03, P-3325-02)
Broström Tor (P-2231-01, P-3305-17, O-2231-10)
Brou, T. (P-2215-10, O-1119a-01)
Brouwer Floor (O-2223-01)
Brovking Victor (K-2217-08, K-1101-02)
# INDEX OF AUTHORS

<table>
<thead>
<tr>
<th>Author</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burke Eleanor</td>
<td>P-1116-03</td>
</tr>
<tr>
<td>Burkowski, Marilyn</td>
<td>P-2213-01</td>
</tr>
<tr>
<td>Bursztyn, Marcel</td>
<td>P-2240-16</td>
</tr>
<tr>
<td>Burte Julien</td>
<td>P-2215-06</td>
</tr>
<tr>
<td>Burton Ian</td>
<td>P-4406-01</td>
</tr>
<tr>
<td>Burton Jesse</td>
<td>O-3306-02</td>
</tr>
<tr>
<td>Busch Jonah</td>
<td>O-2219-05</td>
</tr>
<tr>
<td>Bustamante Mercedes</td>
<td>P-2215-09</td>
</tr>
<tr>
<td>Bustin Van</td>
<td>O-2211-01</td>
</tr>
<tr>
<td>Bustinza Victor</td>
<td>O-2211-02</td>
</tr>
<tr>
<td>Butchart, S.</td>
<td>O-4418b-01</td>
</tr>
<tr>
<td>Butler Paul</td>
<td>P-1102-17</td>
</tr>
<tr>
<td>Butterbach–Bahl, Klaus</td>
<td>O-1115-03</td>
</tr>
<tr>
<td>Buurman Merret</td>
<td>P-2219-04, P-2219-02</td>
</tr>
<tr>
<td>Buytaert Wouter</td>
<td>P-2212b-01</td>
</tr>
<tr>
<td>Byass Peter</td>
<td>P-3321-17</td>
</tr>
<tr>
<td>Byrne, John</td>
<td>P-4415-09, P-2228-012</td>
</tr>
<tr>
<td>Byrne Robert</td>
<td>P-4413-02</td>
</tr>
<tr>
<td>Caballero Yvan</td>
<td>P-2212b-08, P-2212b-04</td>
</tr>
<tr>
<td>Cabalzar Aloisio</td>
<td>K-L3.5-02</td>
</tr>
<tr>
<td>Cabello Angels</td>
<td>K-L3.5-08, P-2234-03</td>
</tr>
<tr>
<td>Cabrera, Olivia</td>
<td>P-1119-05</td>
</tr>
<tr>
<td>Cadarso Maria Angeles</td>
<td>P-4409-05</td>
</tr>
<tr>
<td>Caddell Richard</td>
<td>K-2209-04</td>
</tr>
<tr>
<td>Cadelina Patrick Lawrence</td>
<td>P2209-07</td>
</tr>
<tr>
<td>Cadena Angela</td>
<td>P-2230-02</td>
</tr>
<tr>
<td>Cadilhac, Laurent</td>
<td>P-2212b-04</td>
</tr>
<tr>
<td>Caetano Tara</td>
<td>K-L2.2-04, P-4402-16, O-4411-01</td>
</tr>
<tr>
<td>Cahill Niamh</td>
<td>O-1122-04</td>
</tr>
<tr>
<td>Cailliez Vincent</td>
<td>P-1113-03</td>
</tr>
<tr>
<td>Cai Wenjia</td>
<td>P-3321-17</td>
</tr>
<tr>
<td>Cai Wenju</td>
<td>O-1110-01</td>
</tr>
<tr>
<td>Cai Yanjun</td>
<td>P-2239-02</td>
</tr>
<tr>
<td>Calanca Pierluigi</td>
<td>O-2211-02</td>
</tr>
<tr>
<td>Caldeira Ken</td>
<td>P-3301-05</td>
</tr>
<tr>
<td>Caldwell I</td>
<td>P-2201-03</td>
</tr>
<tr>
<td>Calel Raphael</td>
<td>P-3322-02</td>
</tr>
<tr>
<td>Calfucoy Paulina</td>
<td>O-2239-03</td>
</tr>
<tr>
<td>Callaghan, Sarah</td>
<td>P-4418-16</td>
</tr>
<tr>
<td>Calmant, S.</td>
<td>O-1111b-03, O-1111b-02</td>
</tr>
<tr>
<td>Calmettes Beatriz</td>
<td>O-2209-01</td>
</tr>
<tr>
<td>Calvet Jean–Christophe</td>
<td>K-2218-03, P-1102-03</td>
</tr>
<tr>
<td>Calvin Katherine</td>
<td>K-2217-03, O-3335-03</td>
</tr>
<tr>
<td>Camaiti, Mara</td>
<td>O-2231-03</td>
</tr>
<tr>
<td>Camara, Abdoulaye</td>
<td>P-3330-13</td>
</tr>
<tr>
<td>Cámara, Gilbert</td>
<td>P-2214-14, O-2219-04, P-2219-02</td>
</tr>
<tr>
<td>Camara Mariama</td>
<td>P-2244-01</td>
</tr>
<tr>
<td>Camara Moctar</td>
<td>O-3330a-03</td>
</tr>
<tr>
<td>Camberlin, P.</td>
<td>P-2215-10</td>
</tr>
<tr>
<td>Caminade Cyril</td>
<td>P-3330-57, O-3330b-03</td>
</tr>
<tr>
<td>Cammas Jean–Pierre</td>
<td>P-1105-19, P-1105-03</td>
</tr>
<tr>
<td>Campagnolo Lorenza</td>
<td>K-3308-06, P-3320-11</td>
</tr>
<tr>
<td>Campbell–Lendrum Diarmid</td>
<td>O-3321-03</td>
</tr>
<tr>
<td>Campbell, Andrew</td>
<td>O-4418a-02</td>
</tr>
<tr>
<td>Camp Joanne</td>
<td>P-1117-33</td>
</tr>
<tr>
<td>Campos Edmo</td>
<td>O-1110-02</td>
</tr>
<tr>
<td>Campos Fernando</td>
<td>O-1110-05</td>
</tr>
<tr>
<td>Camuffo Dario</td>
<td>P-2231-01, O-2231-10</td>
</tr>
<tr>
<td>Canadell Josep P.</td>
<td>P-1114-02, P-1114-11</td>
</tr>
<tr>
<td>Cañas Ramírez Lidia</td>
<td>P-2217-21, P-1115-02, P-1116-08, P-1123-02</td>
</tr>
<tr>
<td>Cañaveras Jc.</td>
<td>P-1115-01</td>
</tr>
<tr>
<td>Caney S.</td>
<td>K-L4.5-01</td>
</tr>
<tr>
<td>Caniaux Guy</td>
<td>O-1106-01</td>
</tr>
<tr>
<td>Cantet Philippe</td>
<td>P-2236-10</td>
</tr>
<tr>
<td>Author Name</td>
<td>Code (Page Numbers)</td>
</tr>
<tr>
<td>-------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>Carr, Marco</td>
<td>P-1117-11, P-2214-02</td>
</tr>
<tr>
<td>Carrer Lorenzo</td>
<td>O-3322b-03</td>
</tr>
<tr>
<td>Carrer Dominique</td>
<td>K-2218-03, P-1102-03</td>
</tr>
<tr>
<td>Carter, Lionel</td>
<td>P-1107-06</td>
</tr>
<tr>
<td>Carter Sarah</td>
<td>K-2218-01, O-2219-06</td>
</tr>
<tr>
<td>Cartier Rosine</td>
<td>O-1101-02</td>
</tr>
<tr>
<td>Carvajal Danilo</td>
<td>P-3315-04</td>
</tr>
<tr>
<td>Carvalho Resende Tales</td>
<td>P-2212a-10</td>
</tr>
<tr>
<td>Carvalho Alexandre X. Y.</td>
<td>P-2214-14, O-2219-04, P-2219-02</td>
</tr>
<tr>
<td>Carvalho Leila</td>
<td>P-1117-35</td>
</tr>
<tr>
<td>Carvalho Luis</td>
<td>O-1114-03</td>
</tr>
<tr>
<td>Carvallo, Juan Pablo</td>
<td>O-2237b-03</td>
</tr>
<tr>
<td>Casado M.</td>
<td>K-L1.1-02</td>
</tr>
<tr>
<td>Casas, Jérôme</td>
<td>P-2214-17</td>
</tr>
<tr>
<td>Casassa, Gino</td>
<td>P-1107-11, P-1107-12</td>
</tr>
<tr>
<td>Cassar May</td>
<td>O-2231-08</td>
</tr>
<tr>
<td>Cass, Claire</td>
<td>P-3330-33</td>
</tr>
<tr>
<td>Cassen Christophe</td>
<td>P-4406-02, P-2236-03</td>
</tr>
<tr>
<td>Castagnoli G.</td>
<td>O-3326-03</td>
</tr>
<tr>
<td>Castebrunet Hélène</td>
<td>O-2211-04</td>
</tr>
<tr>
<td>Castellanos Edwin</td>
<td>K-L3.5-03, P-2219-03, O-2211-01</td>
</tr>
<tr>
<td>Castillo Nadia</td>
<td>O-4417-03</td>
</tr>
<tr>
<td>Castro Paula</td>
<td>P-2243-11, O-2239-01, P-2240-04</td>
</tr>
<tr>
<td>Cattaneo Andrea</td>
<td>P-2219-04, P-2240-06</td>
</tr>
<tr>
<td>Cattaneo Cristina</td>
<td>P-2242-05, P-4415-05</td>
</tr>
<tr>
<td>Caubel Julie</td>
<td>K-2218-03</td>
</tr>
<tr>
<td>Caurla Sylvain</td>
<td>O-2216-03</td>
</tr>
<tr>
<td>Cavarero Virgil</td>
<td>O-1111a-01</td>
</tr>
<tr>
<td>Cavatassi Romina</td>
<td>P-2240-06</td>
</tr>
<tr>
<td>Cayla Jean-Michel</td>
<td>P-3303-05</td>
</tr>
<tr>
<td>Cayocca Florence</td>
<td>P-2210-06</td>
</tr>
<tr>
<td>Cayossi Ulrich Alle</td>
<td>P-1117-07</td>
</tr>
<tr>
<td>Author Name</td>
<td>Code(s)</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>Cazenave- Piarrot Alain</td>
<td>P-2228-014</td>
</tr>
<tr>
<td>Cazenave, Frederic</td>
<td>P-3330-34</td>
</tr>
<tr>
<td>Cazenave Anny</td>
<td>P-4418-19, P-1107-01</td>
</tr>
<tr>
<td>Cazenave Anny</td>
<td>K-1105a-03, O-1107-01, K-1122-01</td>
</tr>
<tr>
<td>Ceccato Pietro</td>
<td>P-1104-10, P-4418-06</td>
</tr>
<tr>
<td>Ceglar Andrej</td>
<td>P-2223-17</td>
</tr>
<tr>
<td>Ceotto Paula</td>
<td>P-2244-02</td>
</tr>
<tr>
<td>Cesaire Gnanglé</td>
<td>P-3330-72</td>
</tr>
<tr>
<td>Cesar Hakizimana</td>
<td>P-3320-07</td>
</tr>
<tr>
<td>Cesario Manuel</td>
<td>P-3321-02</td>
</tr>
<tr>
<td>Cesario Raquel Rangel</td>
<td>P-3321-02</td>
</tr>
<tr>
<td>Cesatti Alessandro</td>
<td>P-2217-06, P-2217-23, K-2217-01</td>
</tr>
<tr>
<td>Ceschio Eric</td>
<td>P-1115-06</td>
</tr>
<tr>
<td>Ceulemans, Reinhart</td>
<td>P-1115-07</td>
</tr>
<tr>
<td>Chabi Abad</td>
<td>P-1115-06</td>
</tr>
<tr>
<td>Chabi Philippe A. B.</td>
<td>P-1117-50</td>
</tr>
<tr>
<td>Chacon Miguel</td>
<td>P-3335-03</td>
</tr>
<tr>
<td>Chafe, Oriana</td>
<td>P-1116-15</td>
</tr>
<tr>
<td>Chakrabarty Ranajit</td>
<td>O-3332-01</td>
</tr>
<tr>
<td>Chakrabarty Somarata</td>
<td>O-3332-01</td>
</tr>
<tr>
<td>Chakraborty Kunal</td>
<td>P-1116-04</td>
</tr>
<tr>
<td>Challinor Andy</td>
<td>P-3330-67</td>
</tr>
<tr>
<td>Chalmers, Hannah</td>
<td>O-3307-01 (part2)</td>
</tr>
<tr>
<td>Chalvet-Monfray Karine</td>
<td>P-2224-04</td>
</tr>
<tr>
<td>Chan Joo Jang</td>
<td>K-2209-03</td>
</tr>
<tr>
<td>Chane-Ming Fabrice</td>
<td>P-3330-40</td>
</tr>
<tr>
<td>Chan Sander</td>
<td>O-4410-01</td>
</tr>
<tr>
<td>Chantasiriwan Somchart</td>
<td>P-3305-03</td>
</tr>
<tr>
<td>Chanza N.</td>
<td>P-3328-09</td>
</tr>
<tr>
<td>Chapin Iii F. Stuart</td>
<td>P-1116-01</td>
</tr>
<tr>
<td>Chaplot Vincent</td>
<td>P-2217-01</td>
</tr>
<tr>
<td>Chapman, Sandra</td>
<td>O-4418b-04</td>
</tr>
<tr>
<td>Chapman Christopher</td>
<td>P-1111-06</td>
</tr>
<tr>
<td>Chapuis-Lardy Lydie</td>
<td>P-3325-02</td>
</tr>
<tr>
<td>Chapungu Lazarus</td>
<td>P-3330-14</td>
</tr>
<tr>
<td>Charbit Sylvie</td>
<td>O-2242-03</td>
</tr>
<tr>
<td>Charles Leon</td>
<td>K-2203-02</td>
</tr>
<tr>
<td>Charlier, Jean-Baptiste</td>
<td>P-2212b-04</td>
</tr>
<tr>
<td>Charlotte Berg</td>
<td>P-3322-08</td>
</tr>
<tr>
<td>Charlton-Perez Andrew</td>
<td>P-1108-01, O-1108-01</td>
</tr>
<tr>
<td>Charman Daniel</td>
<td>O-1116-02</td>
</tr>
<tr>
<td>Charneau Vivien</td>
<td>P-4409-06</td>
</tr>
<tr>
<td>Charrière Bruno</td>
<td>P-1111-04</td>
</tr>
<tr>
<td>Chatani, Satoru</td>
<td>P-3305-06</td>
</tr>
<tr>
<td>Chateau Jean</td>
<td>K-3308-06</td>
</tr>
<tr>
<td>Chate Dilip</td>
<td>O-1121-04</td>
</tr>
<tr>
<td>Chatwood, Susan</td>
<td>P-3321-15</td>
</tr>
<tr>
<td>Chau Phi</td>
<td>P-1123-16</td>
</tr>
<tr>
<td>Chauvin Anne</td>
<td>O-2207-03</td>
</tr>
<tr>
<td>Chauvin Fabrice</td>
<td>O-1113-09, P-1102-13</td>
</tr>
<tr>
<td>Chavaillaz Yann</td>
<td>O-2202-03</td>
</tr>
<tr>
<td>Chave Jérôme</td>
<td>K-2215-01, O-2219-02</td>
</tr>
<tr>
<td>Chavez Jara Steven</td>
<td>P-2211-06</td>
</tr>
<tr>
<td>Chavez Eric</td>
<td>P-2239-03, P-3306-04</td>
</tr>
<tr>
<td>Chazarin Florie</td>
<td>P-2217-15</td>
</tr>
<tr>
<td>Cheddadi, Rachid</td>
<td>P-3330-13</td>
</tr>
<tr>
<td>Cheewaphongphan, Penwadee</td>
<td>P-3305-06</td>
</tr>
<tr>
<td>Chekuimo Georges Herbert</td>
<td>P-2228-01</td>
</tr>
<tr>
<td>Chen, Chen-Tung Arthur</td>
<td>P-1110-07</td>
</tr>
<tr>
<td>Chen, Guangsheng</td>
<td>P-1114-11</td>
</tr>
<tr>
<td>Chen, Meng-Chang</td>
<td>P-3321-11</td>
</tr>
<tr>
<td>Chen, Zhaohui</td>
<td>O-1110-01</td>
</tr>
<tr>
<td>Chen Chao-An</td>
<td>P-1113-05</td>
</tr>
<tr>
<td>Chen Chu-Chih</td>
<td>P-3321-01</td>
</tr>
<tr>
<td>Chenet Nicolas</td>
<td>P-2219-11</td>
</tr>
<tr>
<td>Chen Feibei</td>
<td>P-4413-03</td>
</tr>
</tbody>
</table>
Chowdhury, Sp (P-3315-11)
Christensen, Bent T (P-1116-11)
Christensen, Ole Bøssing (O-3303-01)
Christoffersen Bradley (O-2204-04)
Christopher Conrad (P-2217-18)
Chuine Isabelle (O-1121-05)
Chukwuma Peter (P-3330-15)
Chun, Hye-Yeong (P-1108-06)
Chung Jing Xiang (P-1117-28)
Chung Uran (P-2223-04)
Chunho Cho (P-2223-12)
Ciais Philippe (K-L2.2-02, O-1119b-01, P-3330-64, P-1115-15, K-1116-02, O-2217-02, O-2219-02, P-1114-02, P-1114-11, P-3307-01, P-1105-09, P-2204-14, P-1115-12, P-1116-06)
Cindrić Kalin, Ksenija (P-1113-12)
Cirelli Claudia (P-3326-07)
Ciscar Juan Carlos (O-2237a-01)
Cisowska, Iwona (O-2244-01)
Cissé Mouhamed Talla (P-3320-09)
Cisse Niapégué Pierre (P-2242-03)
Claessen Lieven (O-3320-03)
Claeys Florian (P-2215-03, P-3331-01, P-2216-03)
Clarke, Jamie (P-4419-03)
Clarke Darren (P-3312-09)
Clarke Leon (O-3305-02, K-4402a-01)
Claud Chantal (O-1108-03, O-1108-02)
Claudet Joachim (P-2236-11)
Claudia Ghisetti (O-3339-03)
Claus, Simon (O-1105b-02)
Claussen Martin (K-1101-02)
Claustre Hervé (P-1111-03, P-1111-13)
Clément-Chastel, Céline (O-3327-02)
Clément Tchawoua (P-3330-83)
<table>
<thead>
<tr>
<th>Author Name</th>
<th>Index Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clevers, Jan</td>
<td>P-2219-05</td>
</tr>
<tr>
<td>Cloutier Geneviève</td>
<td>P-2239-04</td>
</tr>
<tr>
<td>Cobb Jonathan</td>
<td>P-3303-06</td>
</tr>
<tr>
<td>Cobb Kim</td>
<td>O-1117-01</td>
</tr>
<tr>
<td>Cochran Ian</td>
<td>P-4404-02, P-4404-01</td>
</tr>
<tr>
<td>Codilan Analyn</td>
<td>P-3325-03</td>
</tr>
<tr>
<td>Coelho Andrea</td>
<td>P-2236-08</td>
</tr>
<tr>
<td>Cohan Jean–Pierre Arvalis</td>
<td>P-2225-06</td>
</tr>
<tr>
<td>Cohard Jean–Martial</td>
<td>P-3330-52</td>
</tr>
<tr>
<td>Cohen, Deborah</td>
<td>O-3329-06</td>
</tr>
<tr>
<td>Cohen, Olivier</td>
<td>O-3342-02</td>
</tr>
<tr>
<td>Cohen Brett</td>
<td>P-4418-07</td>
</tr>
<tr>
<td>Cohen Marianne</td>
<td>O-3325b-02</td>
</tr>
<tr>
<td>Cointe Beatrice</td>
<td>P-2236-03, P-3315-05</td>
</tr>
<tr>
<td>Colbourn Tim</td>
<td>P-3321-17</td>
</tr>
<tr>
<td>Cole Daniel</td>
<td>P-4409-07</td>
</tr>
<tr>
<td>Coleman Jo</td>
<td>P-3315-06</td>
</tr>
<tr>
<td>Colette Augustin</td>
<td>O-2205-03, O-3303-01, O-1121-02, O-1121-05</td>
</tr>
<tr>
<td>Colfescu Ioana</td>
<td>P-1118-02</td>
</tr>
<tr>
<td>Colin Marie</td>
<td>O-2230-02</td>
</tr>
<tr>
<td>Coll, Lluis</td>
<td>O-2244-06</td>
</tr>
<tr>
<td>Colleoni Florence</td>
<td>P-1101-03</td>
</tr>
<tr>
<td>Collier Ute</td>
<td>P-3305-04</td>
</tr>
<tr>
<td>Collins Matthew</td>
<td>P-3321-17, K-1111a-03, K-L1.5-03</td>
</tr>
<tr>
<td>Collins William</td>
<td>O-1115-06</td>
</tr>
<tr>
<td>Collof Matthew</td>
<td>K-2214-02, K-2220-01</td>
</tr>
<tr>
<td>Colnenne–David Caroline</td>
<td>P-2218-05</td>
</tr>
<tr>
<td>Colomb A</td>
<td>P-1105-03</td>
</tr>
<tr>
<td>Colombert Morgane</td>
<td>P-4415-02</td>
</tr>
<tr>
<td>Colombier Michel</td>
<td>K-4402b-02</td>
</tr>
<tr>
<td>Comaty Farid</td>
<td>O-4412-01</td>
</tr>
<tr>
<td>Combes, Jean–Louis</td>
<td>K-3308-02</td>
</tr>
<tr>
<td>Combet Emmanuel</td>
<td>P-4405-01, K-3308-05, P-4405-02</td>
</tr>
<tr>
<td>Comiso Josefino</td>
<td>K-1122-03</td>
</tr>
<tr>
<td>Company Joan Batista</td>
<td>K-2208-03</td>
</tr>
<tr>
<td>Conant Rich</td>
<td>K-2223-02</td>
</tr>
<tr>
<td>Conchon Anna</td>
<td>O-2209-01</td>
</tr>
<tr>
<td>Condon Thomas</td>
<td>O-2211-05, P-2211-06, P-1119-13</td>
</tr>
<tr>
<td>Conil, Sébastien</td>
<td>P-1115-12, P-1115-03, P-1115-06</td>
</tr>
<tr>
<td>Connor Stephen</td>
<td>P-1104-10, K-4418b-01</td>
</tr>
<tr>
<td>Conor Walsh</td>
<td>P-4403-02</td>
</tr>
<tr>
<td>Conrad, Mark</td>
<td>O-1116-15</td>
</tr>
<tr>
<td>Conrad Bielski</td>
<td>O-3337-04</td>
</tr>
<tr>
<td>Contreras, Daniel</td>
<td>O-3326-04</td>
</tr>
<tr>
<td>Contreras, Jose</td>
<td>P-3312-18</td>
</tr>
<tr>
<td>Conway Declan</td>
<td>P-2223-07, P-2223-06</td>
</tr>
<tr>
<td>Cook Jolene</td>
<td>P-4418-13</td>
</tr>
<tr>
<td>Cooper Mark</td>
<td>O-1116-02</td>
</tr>
<tr>
<td>Coppola Laurent</td>
<td>O-1110-05</td>
</tr>
<tr>
<td>Corazza Rosana</td>
<td>P-2240-07</td>
</tr>
<tr>
<td>Corbera Esteve</td>
<td>P-2216-07</td>
</tr>
<tr>
<td>Cordeiro Renato Campello</td>
<td>P-1119-12, P-1119-17, O-1119b-02</td>
</tr>
<tr>
<td>Cordonier Segger Marie–Claire</td>
<td>O-3323-03</td>
</tr>
<tr>
<td>Corendeas Cosmin</td>
<td>O-3323-05</td>
</tr>
<tr>
<td>Corfee–Morlot Jan</td>
<td>K-L4.4-02, O-2210-02</td>
</tr>
<tr>
<td>Corlett Richard</td>
<td>O-4418b-01, K-2201-02</td>
</tr>
<tr>
<td>Corner–Dolloff, Caitlin</td>
<td>O-2225-01</td>
</tr>
<tr>
<td>Corner Adam</td>
<td>P-3316-01, P-4419-03</td>
</tr>
<tr>
<td>Cornu, G.</td>
<td>P-2215-10</td>
</tr>
<tr>
<td>Corobov Roman</td>
<td>P-3312-08</td>
</tr>
<tr>
<td>Corrado Topi</td>
<td>O-4407-02</td>
</tr>
<tr>
<td>Corre, Lila</td>
<td>O-1104-04</td>
</tr>
<tr>
<td>Correge Thierry</td>
<td>P-1102-05</td>
</tr>
<tr>
<td>Corti Susanna</td>
<td>O-1122-05</td>
</tr>
<tr>
<td>Author</td>
<td>Index Code</td>
</tr>
<tr>
<td>--------</td>
<td>------------</td>
</tr>
<tr>
<td>Cuezva S</td>
<td>P-1115-01</td>
</tr>
<tr>
<td>Cui Yiyun</td>
<td>O-3320-02</td>
</tr>
<tr>
<td>Cullen Heidi</td>
<td>O-1104-05, P-2240-17</td>
</tr>
<tr>
<td>Cumming Brian</td>
<td>P-3329-04</td>
</tr>
<tr>
<td>Cunsolo Willox, Ashlee</td>
<td>P-3321-15</td>
</tr>
<tr>
<td>Curcoll Roger</td>
<td>P-2217-21, P-1115-02, P-1116-08, P-1123-02</td>
</tr>
<tr>
<td>Curi Melissa</td>
<td>P-2240-14</td>
</tr>
<tr>
<td>Curtis, John</td>
<td>P-1116-15</td>
</tr>
<tr>
<td>Cutting Hunter</td>
<td>P-4419-04</td>
</tr>
<tr>
<td>D. Guo</td>
<td>P-3320-10</td>
</tr>
<tr>
<td>Da Costa Itayguara Ribeiro</td>
<td>P-2215-06</td>
</tr>
<tr>
<td>Da Sié Sylvestre</td>
<td>P-2244-01</td>
</tr>
<tr>
<td>Da Silva José Maria Cardoso</td>
<td>P-2244-02</td>
</tr>
<tr>
<td>Dabissi Noufé</td>
<td>P-3330-16, P-3330-41</td>
</tr>
<tr>
<td>Dacosta, Honoré</td>
<td>P-3330-19</td>
</tr>
<tr>
<td>Dado Julie</td>
<td>P-1102-04, P-1117-28</td>
</tr>
<tr>
<td>Dadson, S</td>
<td>O-1118b-05</td>
</tr>
<tr>
<td>Dahan Amy</td>
<td>O-2241-01</td>
</tr>
<tr>
<td>Dahl–Jensen Dorthe</td>
<td>K-1122-02</td>
</tr>
<tr>
<td>Dahl Arthur L.</td>
<td>O-4418b-03</td>
</tr>
<tr>
<td>Daigneault Adam</td>
<td>P-4402-12</td>
</tr>
<tr>
<td>Dai Yixin</td>
<td>O-4413b-01</td>
</tr>
<tr>
<td>Dakka Abebe Shiferaw</td>
<td>P-3329-03</td>
</tr>
<tr>
<td>Dalimunthe Syarifah Aini</td>
<td>P-2229-03</td>
</tr>
<tr>
<td>Dalin C.</td>
<td>K-L1.2-02</td>
</tr>
<tr>
<td>Dallmann Ingrid</td>
<td>P-1117-09</td>
</tr>
<tr>
<td>Dalstein–Richier Laurence</td>
<td>P-3326-12</td>
</tr>
<tr>
<td>Dalton Michael</td>
<td>P-2217-26, P-4412-01</td>
</tr>
<tr>
<td>Dalu Giovanni</td>
<td>P-3330-08</td>
</tr>
<tr>
<td>Daly–Hassen, Hamed</td>
<td>O-2244-06</td>
</tr>
<tr>
<td>Daly Hannah</td>
<td>P-3316-02</td>
</tr>
<tr>
<td>Cossarini, Gianpiero</td>
<td>P2209-09, P-3320-23</td>
</tr>
<tr>
<td>Costa, Luis</td>
<td>P-4418-16, P-2226-02</td>
</tr>
<tr>
<td>Costantini Valeria</td>
<td>O-3339-03, P-4409-08</td>
</tr>
<tr>
<td>Costello Anthony</td>
<td>P-3321-17</td>
</tr>
<tr>
<td>Coughlan Erin</td>
<td>O-1104-05</td>
</tr>
<tr>
<td>Coulombel Nicolas</td>
<td>P-4413-01</td>
</tr>
<tr>
<td>Coulter Liese</td>
<td>O-4418a-01</td>
</tr>
<tr>
<td>Coumou Dim</td>
<td>O-1113-07, O-4406b-04</td>
</tr>
<tr>
<td>Courbet François</td>
<td>P-3326-10</td>
</tr>
<tr>
<td>Coussy Paula</td>
<td>O-4420b-03</td>
</tr>
<tr>
<td>Couteron Pierre</td>
<td>K-2219-03</td>
</tr>
<tr>
<td>Couvreux Fleur</td>
<td>P-3330-36</td>
</tr>
<tr>
<td>Cox Emily</td>
<td>P-3303-07</td>
</tr>
<tr>
<td>Cox Peter</td>
<td>P-3321-17</td>
</tr>
<tr>
<td>Crabbé Ann</td>
<td>K-3337-01, P-3337-01</td>
</tr>
<tr>
<td>Cramer Wolfgang</td>
<td>K-1118a-02, K-L1.2-06</td>
</tr>
<tr>
<td>Craparo Alessandro</td>
<td>P-2223-05</td>
</tr>
<tr>
<td>Crave, A.</td>
<td>P-1119-13</td>
</tr>
<tr>
<td>Crawford–Brown Doug</td>
<td>O-3317-04</td>
</tr>
<tr>
<td>Creswick James</td>
<td>O-1121-01, P-1123-08</td>
</tr>
<tr>
<td>Creutzig Felix</td>
<td>P-4409-15, O-3316-01, O-2229-07</td>
</tr>
<tr>
<td>Crick Florence</td>
<td>O-4408-01</td>
</tr>
<tr>
<td>Crijns–Graus Wina</td>
<td>P-3305-20</td>
</tr>
<tr>
<td>Criqui Patrick</td>
<td>O-3318-02, K-4402b-03</td>
</tr>
<tr>
<td>Critto Andrea</td>
<td>P-2204-13</td>
</tr>
<tr>
<td>Crochet Jean–Charles</td>
<td>K-4415a-02</td>
</tr>
<tr>
<td>Cronin Casey</td>
<td>P-3311-09</td>
</tr>
<tr>
<td>Crooks Susan</td>
<td>O-1118a-02</td>
</tr>
<tr>
<td>Crosta Xavier</td>
<td>P-1102-10</td>
</tr>
<tr>
<td>Cruz F.w.</td>
<td>P-1119-03</td>
</tr>
<tr>
<td>Cruz Faye</td>
<td>P-1102-04, P-1117-28</td>
</tr>
<tr>
<td>Cudennec Christophe</td>
<td>K-2212b-02</td>
</tr>
<tr>
<td>Cuet Pascale</td>
<td>O-2207-03</td>
</tr>
</tbody>
</table>
INDEX OF AUTHORS

Dambach Peter (O-2226-03, O-3321-07)
Dameris Martin (P-1108-05, O-1108-05)
Damoah, Richard (O-1116-03)
Danbasoglu Gokhan (P-1106-04)
Dandin Philippe (P-1105-19, O-1104-04)
Dangian Jérôme (K-2202-03)
Dangles Olivier (P-2224-05)
Dangour Alan (O-2226-05)
Daniault, Nathalie (O-1110-04)
Danis Pierre-Alain (P-3326-09)
Dankers, Rutger (P-2205-11)
Dannevi Halvor (O-2239-04)
Danovaro Roberto (O-1106-02)
Danzer, Julia (P-1105-09)
Dao Amidou (P-3330-17)
Dardel Cecile (P-3330-65)
Dardel Cécile (P-3330-35, O-3330b-02)
Dargusch Paul (P-1114-13)
Daron Joseph (O-4408-04)
Daron Joseph (P-2222-11, P-2236-17)
Das Dhirman (P-2214-03)
Dasgupta Shouro (P-3321-03)
Da Silva, Carolina (P-2240-16)
Daszak Peter (O-2226-01)
Dau C (P-2201-03)
Daures Maguy (O-1111a-01)
Davide Antonioli (O-3339-03)
Davide Poletto (O-3337-04)
David Gilbert (P-1111-07)
David Monkaam (P-3330-84)
David Romain (P2209-10)
David Victor (P-1111-07)
David Von Below (P-4412-02)
Davies-Barnard Taraka (P-2217-07, P-2218-09)
Davin L. Edouard (P-1114-05)
Davis, Frank (O-4418a-02)
Davis Steven (K-3306-03)
Day, Jennifer (P-3315-03)
Day, Thomas (O-4402b-01)
Dayan, Hugo (O-4414-01)
Dayan, Léo (P-3330-49)
Dayawon Raul S (P-2217-30)
Dayon Gildas (P-2205-02)
Day Shane (P-2236-04)
De Aragão Ribeiro Rodrigues Renato (O-1119b-02)
De Bievre Bert (O-2212b-01)
De Boer W. F. (P-2214-13)
De Bruin Karianne (P-2224-06)
De Cara Stéphane (P-2218-05, P-3339-01)
De Cian Enrica (P-2223-14, K-2237a-03, O-2237a-02)
De Dreuzy Jean-Raynald (P-2212b-08)
De Freitas Debora (O-2243-04)
De Galembernt Bernard (O-3314-01)
De La Broise Denis (P-3302-01)
De La Camara Alvaro (P-1108-03)
De Lapparent Benjamin (P-2215-10)
De Lattre-Gasquet Marie (P-2236-05)
De Leeuw Gerrit (P-1105-04, P-1105-04)
De Longueville Florence (O-2242-05)
De Marco Alessandra (P-3326-12)
De Melo Jaime (O-4403-01)
De Michele Marcello (P-1107-13)
De Noblet–Ducoudré Nathalie (K-2217-08, O-2217-02, O-2222-04, P-2217-23, K-2218-03, K-2217-01, P-2217-28)
De Paula Correa Marcelo (P-2226-04, P-2226-03, K-2226-03)
<table>
<thead>
<tr>
<th>Author Name</th>
<th>Reference Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>De Perthuis Christian</td>
<td>P-4409-10</td>
</tr>
<tr>
<td>De Pinto Alessandro</td>
<td>O-2217-01, P-2217-12, P-2219-08</td>
</tr>
<tr>
<td>De Pryck Kari</td>
<td>P-2236-06</td>
</tr>
<tr>
<td>De Ramon N’yeurt Antoine</td>
<td>P-1105-05, P-4413-04</td>
</tr>
<tr>
<td>De Reseguier Laure</td>
<td>P-2224-21</td>
</tr>
<tr>
<td>De Sepibus Joelle</td>
<td>P-4409-11</td>
</tr>
<tr>
<td>De Sherbinin Alex</td>
<td>O-1105b-01</td>
</tr>
<tr>
<td>De Soto Isabel S.</td>
<td>P-1116-05</td>
</tr>
<tr>
<td>De Sy Veronica</td>
<td>K-2218-01, P-2219-05</td>
</tr>
<tr>
<td>De Vallavielle-Pope Claude</td>
<td>P-2224-07</td>
</tr>
<tr>
<td>Dean, Sam</td>
<td>P-1119-07</td>
</tr>
<tr>
<td>Debaeke Philippe</td>
<td>P-2224-04</td>
</tr>
<tr>
<td>De Baets, Sarah</td>
<td>P-1116-14</td>
</tr>
<tr>
<td>Deboissieu Florian</td>
<td>P-1111-14</td>
</tr>
<tr>
<td>Dechezleprêtre Antoine</td>
<td>O-3315-02, O-4420a-01</td>
</tr>
<tr>
<td>De Deurwaerder Hannes</td>
<td>O-2204-04</td>
</tr>
<tr>
<td>Dedieu Jean-Pierre</td>
<td>O-2211-05</td>
</tr>
<tr>
<td>Dee Dick</td>
<td>O-2232-02</td>
</tr>
<tr>
<td>Deepthi Wickramasinghe</td>
<td>P-2210-07</td>
</tr>
<tr>
<td>Deffontaines Sylvain</td>
<td>O-2218-03</td>
</tr>
<tr>
<td>Defrance Dimitri</td>
<td>O-2242-03</td>
</tr>
<tr>
<td>Defries Ruth</td>
<td>O-2215-02</td>
</tr>
<tr>
<td>Degallier Nicolas</td>
<td>O-1111a-01</td>
</tr>
<tr>
<td>Degefa Aynalem</td>
<td>P-3329-04</td>
</tr>
<tr>
<td>Deheza Mariana</td>
<td>P-2219-11</td>
</tr>
<tr>
<td>Dekeyzer, Stefanie</td>
<td>O-1105b-02</td>
</tr>
<tr>
<td>Del Corral John</td>
<td>P-4418-06</td>
</tr>
<tr>
<td>Delacote Philippe</td>
<td>O-2216-03, P-2216-03, K-2218-03</td>
</tr>
<tr>
<td>Delage Erick</td>
<td>P-4418-23</td>
</tr>
<tr>
<td>Delalande Silvere</td>
<td>P-1105-14</td>
</tr>
<tr>
<td>Delanghe, Doriane</td>
<td>P-1101-06</td>
</tr>
<tr>
<td>Delavenne Juliette</td>
<td>P-2208-01</td>
</tr>
<tr>
<td>Delaygue Gilles</td>
<td>P-1107-05</td>
</tr>
<tr>
<td>Del Castillo, F P</td>
<td>P-2217-30</td>
</tr>
<tr>
<td>Del Castillo, Luis A.</td>
<td>P-3312-18</td>
</tr>
<tr>
<td>Delgado Pugley Deborah</td>
<td>P-2219-06</td>
</tr>
<tr>
<td>Delgado–Confesor Shella</td>
<td>P-1123-13</td>
</tr>
<tr>
<td>Delgado, Luisa E.</td>
<td>P-3322-09</td>
</tr>
<tr>
<td>Delgado Ricardo</td>
<td>P-2230-02</td>
</tr>
<tr>
<td>Delina Laurence</td>
<td>P-4402-05, P-4410-01</td>
</tr>
<tr>
<td>Delire Christine</td>
<td>O-2213-01</td>
</tr>
<tr>
<td>Dellink Rob</td>
<td>P-4409-21, K-2237a-01, K-3308-06</td>
</tr>
<tr>
<td>Delmotte, Marc</td>
<td>P-1115-15, P-1115-12, P-1115-03</td>
</tr>
<tr>
<td>Delpiazzo Elisa</td>
<td>K-4405-02</td>
</tr>
<tr>
<td>Delusca Kenel</td>
<td>O-2223-02</td>
</tr>
<tr>
<td>Delvalls, T. Angel</td>
<td>P-1110-07</td>
</tr>
<tr>
<td>Demarty Jerome</td>
<td>P-3330-65, P-3330-30</td>
</tr>
<tr>
<td>De Mazières M.</td>
<td>P-1105-03</td>
</tr>
<tr>
<td>Deme Abdoulaye</td>
<td>P-3330-21, P-3330-18</td>
</tr>
<tr>
<td>Demunck Cécile</td>
<td>P-4415-07</td>
</tr>
<tr>
<td>Den Elzen Michel</td>
<td>K-L2.2-03, O-4402b-01</td>
</tr>
<tr>
<td>Deneudt Klaas</td>
<td>O-1105b-02</td>
</tr>
<tr>
<td>Deng Houtao</td>
<td>P-2223-09</td>
</tr>
<tr>
<td>Deng Yvonne</td>
<td>O-4412-01</td>
</tr>
<tr>
<td>Dennig Francis</td>
<td>P-3322-03, K-4412-01, P-4412-02</td>
</tr>
<tr>
<td>Dentener Frank</td>
<td>P-2223-17</td>
</tr>
<tr>
<td>Depledge Joanna</td>
<td>P-3321-17</td>
</tr>
<tr>
<td>Depol–Holz, Ricardo</td>
<td>O-1110-05</td>
</tr>
<tr>
<td>Depraetere Christian</td>
<td>O-4418b-03</td>
</tr>
<tr>
<td>Depretz–De–Gesincourt Olivier</td>
<td>O-1110-05</td>
</tr>
<tr>
<td>Déqué Michel</td>
<td>O-2231-02, O-3303-01, O-2211-04</td>
</tr>
<tr>
<td>Dequiedt, Samuel</td>
<td>P-1116-11</td>
</tr>
<tr>
<td>Deryng Delphine</td>
<td>P-2223-07, P-2223-06</td>
</tr>
<tr>
<td>De Sassi, C.</td>
<td>O-2219-01</td>
</tr>
<tr>
<td>Desbruyères Damien</td>
<td>O-1110-04</td>
</tr>
<tr>
<td>Deschamps, Pierre</td>
<td>P-1101-06</td>
</tr>
<tr>
<td>Author Name</td>
<td>Page Numbers</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Descloux Elodie</td>
<td>O-1111a-01</td>
</tr>
<tr>
<td>Desonnets Jean–Chrisophe</td>
<td>P-4418-22</td>
</tr>
<tr>
<td>Descoureaux Dominique</td>
<td>P-2224-07</td>
</tr>
<tr>
<td>Descroix Luc</td>
<td>P-3330-33, P-3330-65, P-3330-19, O-1119b-05</td>
</tr>
<tr>
<td>Desenclos Jean–Claude</td>
<td>O-2226-02</td>
</tr>
<tr>
<td>Deser Clara</td>
<td>O-1117-01, K-1117-02</td>
</tr>
<tr>
<td>Desiderio, A.</td>
<td>P-1119-13</td>
</tr>
<tr>
<td>Despinoy, Marc</td>
<td>P-4418-05</td>
</tr>
<tr>
<td>Desramaut Nicolas</td>
<td>P-2211-01</td>
</tr>
<tr>
<td>Dessai Suraje</td>
<td>K-2239-01, O-2240-02, P-4419-02</td>
</tr>
<tr>
<td>Dessay, Nadine</td>
<td>P-4418-22</td>
</tr>
<tr>
<td>Dessens Olivier</td>
<td>P-4402-06</td>
</tr>
<tr>
<td>Dessert Céline</td>
<td>P-1119-04</td>
</tr>
<tr>
<td>Dessert Morgane</td>
<td>O-2209-01, P2209-01</td>
</tr>
<tr>
<td>Deveatii Dumitru</td>
<td>P-1102-18</td>
</tr>
<tr>
<td>Deves Maud</td>
<td>P-2236-06</td>
</tr>
<tr>
<td>Deves Maud</td>
<td>P-4418-08</td>
</tr>
<tr>
<td>Devezearoux De Lavergne Jean–Guy</td>
<td>K-4402b-03</td>
</tr>
<tr>
<td>Devries, Tim</td>
<td>O-1110-05</td>
</tr>
<tr>
<td>Dewilde, Fabien</td>
<td>O-1110-05</td>
</tr>
<tr>
<td>Dewitte Boris</td>
<td>O-1115-04, O-1110-05</td>
</tr>
<tr>
<td>Dewulf, Art</td>
<td>P-4407-03</td>
</tr>
<tr>
<td>Deyoung Cassandra</td>
<td>O-3320-04</td>
</tr>
<tr>
<td>Dezetoz, Alain</td>
<td>P-2212b-05</td>
</tr>
<tr>
<td>Dezileau Laurent</td>
<td>O-1119b-03</td>
</tr>
<tr>
<td>Dhakal, Yuba Raj</td>
<td>P-2214-02</td>
</tr>
<tr>
<td>Dhakal Shobhakar</td>
<td>O-3322a-01</td>
</tr>
<tr>
<td>Dhungana Anal</td>
<td>P-2214-04</td>
</tr>
<tr>
<td>Di Paolo Arianna</td>
<td>O-3320-08</td>
</tr>
<tr>
<td>Di Tuccio Maria Concetta</td>
<td>P-3305-17</td>
</tr>
<tr>
<td>Diaconescu Emilia</td>
<td>P-3330-66</td>
</tr>
<tr>
<td>Diakova, Katka</td>
<td>P-1116-14</td>
</tr>
<tr>
<td>Diallo Binta</td>
<td>P-3330-36</td>
</tr>
<tr>
<td>Diallo Ismaila</td>
<td>P-1117-47, P-3330-75</td>
</tr>
<tr>
<td>Diamond, Howard J.</td>
<td>P-1105-10</td>
</tr>
<tr>
<td>Dias Carlos Wendell Soares</td>
<td>P-1117-31</td>
</tr>
<tr>
<td>Dias Luís</td>
<td>P-2230-05</td>
</tr>
<tr>
<td>Diatta Clément</td>
<td>P-3320-09</td>
</tr>
<tr>
<td>Diawara Adama</td>
<td>P-3330-09, P-2212a-03, P-1117-16, P-1117-51, P-1115-03</td>
</tr>
<tr>
<td>Diaz, L.</td>
<td>P-1102-19</td>
</tr>
<tr>
<td>Díaz Manuel</td>
<td>P-2236-07</td>
</tr>
<tr>
<td>Díaz Rafael</td>
<td>K-L3.5-03</td>
</tr>
<tr>
<td>Diba Ibrahima</td>
<td>O-3330a-03</td>
</tr>
<tr>
<td>Dibi N’da Hyppolite</td>
<td>O-2244-02</td>
</tr>
<tr>
<td>Diboulo, Eric</td>
<td>P-1117-06, P-2232-01</td>
</tr>
<tr>
<td>Dickinson Maria</td>
<td>K-2214-03</td>
</tr>
<tr>
<td>Diedhiou Arona</td>
<td>P-2212a-03, P-1117-47, P-1117-16, P-1113-18, P-1117-51, P-3330-20, O-3330a-03</td>
</tr>
<tr>
<td>Diekkrüger, Bernd</td>
<td>P-3330-07</td>
</tr>
<tr>
<td>Dieme Yaya</td>
<td>P-3320-09</td>
</tr>
<tr>
<td>Dieng Diarra</td>
<td>P-1104-04</td>
</tr>
<tr>
<td>Dieppois Bastien</td>
<td>P-2212a-03</td>
</tr>
<tr>
<td>Dieppois Bastien</td>
<td>P-3330-10</td>
</tr>
<tr>
<td>Diesendorf Mark</td>
<td>P-4410-01</td>
</tr>
<tr>
<td>Dietmüller, Simone</td>
<td>P-1108-05</td>
</tr>
<tr>
<td>Dietre Benjamin</td>
<td>P-1101-04</td>
</tr>
<tr>
<td>Dietrich B</td>
<td>P-2201-03</td>
</tr>
<tr>
<td>Dietrich Jan</td>
<td>P-2217-13, P-2219-13, P-2218-06</td>
</tr>
<tr>
<td>Dieudonné, Elsa</td>
<td>P-1115-15</td>
</tr>
<tr>
<td>Di Gregorio, Monica</td>
<td>K-2219-01</td>
</tr>
<tr>
<td>Dijkstra, Henk A.</td>
<td>O-1113-06</td>
</tr>
<tr>
<td>Dijkstra Paul</td>
<td>P-1116-13</td>
</tr>
<tr>
<td>Dilorenzo Emanuele</td>
<td>O-1117-01</td>
</tr>
<tr>
<td>Dimiza Margarita</td>
<td>P-3326-05</td>
</tr>
<tr>
<td>Dinerstein Eric</td>
<td>P-2214-01</td>
</tr>
<tr>
<td>Author</td>
<td>Index</td>
</tr>
<tr>
<td>------------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>Döring, Martin</td>
<td>P-2243-13</td>
</tr>
<tr>
<td>Doring Jeff</td>
<td>P-2238-04</td>
</tr>
<tr>
<td>Dorr, Alex</td>
<td>P-4418-12</td>
</tr>
<tr>
<td>Dos Santos Stéphanie</td>
<td>P-3330-22</td>
</tr>
<tr>
<td>Dosio Alessandro</td>
<td>O-1113-02</td>
</tr>
<tr>
<td>Do Thao</td>
<td>P-3330-10</td>
</tr>
<tr>
<td>Dou, Y.</td>
<td>P-2212b-01</td>
</tr>
<tr>
<td>Doucha Tomas</td>
<td>P-3320-07</td>
</tr>
<tr>
<td>Dougill Andrew</td>
<td>P-4406-03</td>
</tr>
<tr>
<td>Doummang, Jean-Claude</td>
<td>P-1101-06</td>
</tr>
<tr>
<td>Dousset Benedicte</td>
<td>P-2201-03</td>
</tr>
<tr>
<td>Doust Ken</td>
<td>P-3322-04</td>
</tr>
<tr>
<td>Douzou Sylvie</td>
<td>O-3317-01</td>
</tr>
<tr>
<td>Dovonou Flavien E.</td>
<td>P-2224-01</td>
</tr>
<tr>
<td>Dragon Anne-Cécile</td>
<td>O-2209-01</td>
</tr>
<tr>
<td>Drapeau Guillaume</td>
<td>O-1119b-01, P-1119-16</td>
</tr>
<tr>
<td>Drenkhan Fabian</td>
<td>P-2211-12</td>
</tr>
<tr>
<td>Dreyfus Magali</td>
<td>P-3305-05</td>
</tr>
<tr>
<td>Drocourt, Yoann</td>
<td>O-3327-02</td>
</tr>
<tr>
<td>Drouet Laurent</td>
<td>K-2237a-03, P-2245-01</td>
</tr>
</tbody>
</table>
INDEX OF AUTHORS

Du–Toit Derick (O–4414–03)
Dubash Navroz (K–L3.1–04, K–L2.2–02, O–3316–01, P–3305–11)
Dubbelboer Jan (O–4408–01)
Dubinsky, Zvy (O–2207–02)
Duboz Priscilla (O–3331–02)
Dubreucq Thierry (O–2230–05)
Dubreuil, Vincent (P–2215–10)
Ducharne Agnès (O–1119b–01, K–2212b–03)
Duché, Sarah (P–2240–12)
Duchêne Eric (P–2224–21)
Duchez Aurélie (P–1113–05)
Duerr Ruth (O–1105b–06)
Dueymes Guillaume (P–3330–66)
Duffaut Espinosa (P–1117–35)
Duflot V. (P–1105–03)
Dufrence, Eric (P–1115–06)
Dufresne, Jean–Louis (O–1102–02, K–2245–01)
Dulal Hari (P–2228–01)
Dumas, Pascal (P–3342–02)
Dumas Christophe (O–2242–03)
Dumas Patrice (P–2223–08, P–2236–05)
Dumont Marie (P–1107–15)
Duncan, James (O–2202–01)
Dunlop Michael (K–2214–02, K–2220–01)
Dupont–Rouzevrol Myrielle (O–1111a–01)
Dupouy Cécile (P–1111–14)
Dupraz Christian (P–2218–01)
Dupraz Pierre (P–2218–05)
Dupros Fabrice (P–4418–09)
Durand–Lasserre Olivier (K–3308–06)
Durand, Yves (O–2211–04)
Durand Bernard (P–1114–03)

Durand Gael (K–1107–02)
Durand Jean–Louis (O–2223–02, P–2217–09)
Durieux Laurent (P–4418–22)
Durrieu De Madron Xavier (O–3326–02)
Dury Marie (P–2202–03)
Duscha Vicki (P–4418–17)
Duteil Olaf (P–1111–08)
Dutheil, Cyril (P–1111–01, O–1111a–01)
Duvail Stéphanie (P–2219–10)
Duvat–Magnan Virginie (O–1111b–03)
Dworkin Michael (O–3303–03)
Dzerefos Cathy (P–3320–10)

E

E. Douville (P–1102–05)
E.j. Huiseng (P–2225–10)
E. Witkowski (P–3320–10)
Eakin Hallie (K–L3.5–03)
Eba’a–Atyi Richard (P–3331–01)
Ebi Kristie (O–3321–01)
Eboli Fabio (P–3320–11)
Eckert Nicolas (P–2211–05, O–2211–04)
Edeline Eric (O–2213–01)
Eder Brigitte (O–2233–04, O–2203–03)
Edge, Victoria (P–3321–15)
Eduardo Calvo (P–4409–01)
Edwards Morgan (P–1114–12)
Edwards Neil (O–2237b–02)
Effendy Mohammad (P–3305–19)
Efitre Jackson (P–1123–03)
Egerer Sab (K–1101–02)
Egl, Thomas (P–1116–11)
INDEX OF AUTHORS

International Scientific Conference     7-10 JULY 2015    PARIS, FRANCE

Elza Kawakami (P-2236–08)
Emiliano Spaltro (O-3337–04)
Emilie Stoll (P-2236–08)
Emmanouil George (P-1113–04)
Emmanuel M. Attua (P-3330–50)
Emmerling Johannes (P-2204–03, P-4409–21, O-4408–05, P-2245–01)
Emori Seita (P-2204–17, P-2202–02, P-4419–01)
Engardt Magnus (O-2205–03)
Engelbrecht, Francois (O-1117–05, O-1116–03)
Engelhardt Robin (P-1123–05)
England Matthew (P-1107–06)
Englund Michel, Sylvia (O-1114–04)
Enjalbert Jérôme (P-2224–07)
Enrique Curchitser (K-2209–03)
Eom Jiyong (O-3305–02, O-4402a–01)
Epstein Michelle A. (O-1121–05)
Equihual Miguel (P-2214–06)
Erb Karl–Heinz (O-2218–02)
Eric Chavez–Betancourt (P-1121–03)
Erickson Peter (K-3306–02)
Éric Servat3 (P-3330–16)
Ermert Volker (P-1117–41)
Ern, Manfred (P-1108–06)
Ernakovich, Jessica (P-1116–14)
Ersken, Vasile (K-1103–01)
Escobar Gutiérrez Abraham Juan (P-2217–09)
Escoffier Stéphanie (P2209–06)
Escolero, Oscar (P-2212a–19)
Espinosa Monica (P-2230–02)
Espinoza, Fabián (P-1107–11)
Espinoza Carlos (P-2238–07)
Espinoza Jhan Carlo (O-1119b–01, P-1119–16, P-2211–06, P-1119–03)

El Haq, Faisal (P-3312–02, P-1117–10)
Elashvili Mikheil (P-2222–03)
Elguindi Nellie (O-3330a–01)
Elhadi Adam (P-2223–09, P-2229–05)
Elas Peter (P-3328–04, P-2244–04)
Eli Vered (P-2225–15)
Ellenbeck Saskia (O-4417–01)
Ellery Alex (O-3301–03)
Elliott Joshua (K-L2.5–02, P-2223–16, P-2223–22, K-2223–03, P-2223–07, O-2202–02)
Ellison, Luke (O-1116–03)
Elmqvist Thomas (K-4415b–01)
Eloi Carlos Márcio De Aquino (P-1117–31)
Elawah, Sondoss (P-3322–06)
Ely Adrian (O-3333–02, K-4413a–01, O-4417–05)
Elyazidi Abdel Hadi (P-1115–12)

Ehrenstein Vera (O-2241–03)
Ehresman Timothy (O-4411–03)
Ehrhardt Fiona (K-2223–02)
Eichhammer Wolfgang (P-3305–01)
Eide Elisabeth (O-4419–01)
Eid Manal (P-1123–04)
Eisenack Klaus (P-4409–12)
Eisner, Stephanie (P-2205–11)
Ekaputri Andini Desita (O-2243–03)
Ekins Paul (P-3315–01, P-3321–17)
Ekwurzel Brenda (P-4412–01, P-4412–06)
El Adlouni Salah (P-1102–16)
El Chami Daniel (P-3312–20)
El Jaafari Samir (P-1121–04)
El Jaafari Samir (P-1117–27)
El Yaacoubi Adnane (P-1117–27)
El Yaacoubi Adnane (P-3326–03)
El-Hag, Faisal (P-3312–02, P-1117–10)
Elbashvili Mikheil (P-2222–03)
Elguindi Nellie (O-3330a–01)
Elhadi Adam (P-2223–09, P-2229–05)
Elas Peter (P-3328–04, P-2244–04)
Eli Vered (P-2225–15)
Ellenbeck Saskia (O-4417–01)
Ellery Alex (O-3301–03)
Elliott Joshua (K-L2.5–02, P-2223–16, P-2223–22, K-2223–03, P-2223–07, O-2202–02)
Ellison, Luke (O-1116–03)
Elmqvist Thomas (K-4415b–01)
Eloi Carlos Márcio De Aquino (P-1117–31)
Elawah, Sondoss (P-3322–06)
Ely Adrian (O-3333–02, K-4413a–01, O-4417–05)
Elyazidi Abdel Hadi (P-1115–12)
INDEX OF AUTHORS

<table>
<thead>
<tr>
<th>Author</th>
<th>Index Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Espinoza Jhan Carlo</td>
<td>O-1119a-02</td>
</tr>
<tr>
<td>Espy P. J.</td>
<td>P-1108-08</td>
</tr>
<tr>
<td>Essens Tijl</td>
<td>P-2214-13</td>
</tr>
<tr>
<td>Essl Franz</td>
<td>O-1121-05</td>
</tr>
<tr>
<td>Estop Aragones Cristian</td>
<td>O-1116-02</td>
</tr>
<tr>
<td>Esty Daniel</td>
<td>O-4403-02</td>
</tr>
<tr>
<td>Etone Cyr Gervais</td>
<td>P-3330-23</td>
</tr>
<tr>
<td>Etiope, Giuseppe</td>
<td>O-1114-04</td>
</tr>
<tr>
<td>Euromed–Ocean2k</td>
<td>O-1103-01</td>
</tr>
<tr>
<td>Evans Amato</td>
<td>P-3330-46</td>
</tr>
<tr>
<td>Evangeliou N.</td>
<td>O-1114-05</td>
</tr>
<tr>
<td>Evangelista Heitor</td>
<td>O-1119b-02</td>
</tr>
<tr>
<td>Evans, Michael</td>
<td>K-1103-01</td>
</tr>
<tr>
<td>Evans, Susan</td>
<td>P-2240-10</td>
</tr>
<tr>
<td>Evans Meredydd</td>
<td>O-3305-02</td>
</tr>
<tr>
<td>Evers Láslo</td>
<td>P-1108-01</td>
</tr>
<tr>
<td>Evison Kapangaziwiri</td>
<td>P-3330-07</td>
</tr>
<tr>
<td>Ewert Frank</td>
<td>O-2223-01</td>
</tr>
<tr>
<td>Exarchou Eleftheria</td>
<td>P-1111-09, O-2245-03</td>
</tr>
<tr>
<td>Eyckmans, Johan</td>
<td>P-4409-21</td>
</tr>
<tr>
<td>Eynaud Frédérique</td>
<td>P-1102-10</td>
</tr>
<tr>
<td>Ezeji Joachim</td>
<td>P-3330-24</td>
</tr>
<tr>
<td>Fabregue Mickael</td>
<td>O-2226-02</td>
</tr>
<tr>
<td>Fabre Julie</td>
<td>P-2212b-05</td>
</tr>
<tr>
<td>Fabricius, Katharina E.</td>
<td>O-2207-02</td>
</tr>
<tr>
<td>Facchini Maria Cristina</td>
<td>O-1106-02</td>
</tr>
<tr>
<td>Fady Bruno</td>
<td>P-3326-10</td>
</tr>
<tr>
<td>Faedo, Giorgio</td>
<td>P-2212a-10</td>
</tr>
<tr>
<td>Fakheran Sima</td>
<td>P-2214-05</td>
</tr>
<tr>
<td>Falcón, Luisa I.</td>
<td>P-2212a-19</td>
</tr>
<tr>
<td>Falge Eva</td>
<td>P-2235-01</td>
</tr>
<tr>
<td>Falina Anastasia</td>
<td>O-1110-04</td>
</tr>
<tr>
<td>Falini, Giuseppe</td>
<td>O-2207-02</td>
</tr>
<tr>
<td>Fallot, Abigail</td>
<td>P-2224-26</td>
</tr>
<tr>
<td>Falus Gyorgy</td>
<td>O-3307-03</td>
</tr>
<tr>
<td>Faluveci G</td>
<td>O-1122-06</td>
</tr>
<tr>
<td>Falzon James</td>
<td>O-3335-03</td>
</tr>
<tr>
<td>Famagan Oulé Konate</td>
<td>P-2242-03</td>
</tr>
<tr>
<td>Fandika Isaac R</td>
<td>P-3330-25</td>
</tr>
<tr>
<td>Fang R</td>
<td>P-2201-03</td>
</tr>
<tr>
<td>Fan Jun</td>
<td>O-3333-03</td>
</tr>
<tr>
<td>Fantazzini, Paola</td>
<td>O-2231-03, O-2207-02</td>
</tr>
<tr>
<td>Farahbakhsh, Khosrow</td>
<td>P-3321-15</td>
</tr>
<tr>
<td>Fargette Mireille</td>
<td>P-4418-03</td>
</tr>
<tr>
<td>Farquhar, James</td>
<td>O-1103-04</td>
</tr>
<tr>
<td>Fasona Mayowa</td>
<td>P-2244-04</td>
</tr>
<tr>
<td>Fatema, Nuzhat</td>
<td>P-2243-10</td>
</tr>
<tr>
<td>Faudon Valerie</td>
<td>K-3302-03</td>
</tr>
<tr>
<td>Faure Jean-François</td>
<td>P-4418-22</td>
</tr>
<tr>
<td>Faverdin Philippe</td>
<td>P-2218-05</td>
</tr>
<tr>
<td>Favier Charly</td>
<td>O-2222-02, P-2215-06</td>
</tr>
<tr>
<td>Favier Vincent</td>
<td>P-1107-05</td>
</tr>
<tr>
<td>Favier Vincent</td>
<td>P-1105-17</td>
</tr>
<tr>
<td>Favre Alice</td>
<td>O-2201-01</td>
</tr>
<tr>
<td>Favreau Guillaume</td>
<td>P-3330-65</td>
</tr>
<tr>
<td>Faye Amy</td>
<td>P-2223-10</td>
</tr>
<tr>
<td>Faye Laurice Codou</td>
<td>P-2216-04</td>
</tr>
<tr>
<td>Fayolle Adeline</td>
<td>K-L4.2-04, P-2215-03</td>
</tr>
<tr>
<td>Fazey Ioan</td>
<td>K-2214-04</td>
</tr>
<tr>
<td>Febianto Mula</td>
<td>P-4414-04</td>
</tr>
<tr>
<td>Fedorova Valentina</td>
<td>P-3321-09</td>
</tr>
<tr>
<td>Feely, Richard</td>
<td>O-2207-04, P-2207-04</td>
</tr>
<tr>
<td>Fei Ge</td>
<td>P-2201-01</td>
</tr>
<tr>
<td>Fekete, Hanna</td>
<td>O-4402b-01, O-4412-01</td>
</tr>
<tr>
<td>Feketeh, Balázs</td>
<td>P-2205-11</td>
</tr>
<tr>
<td>Author Name</td>
<td>ID Numbers</td>
</tr>
<tr>
<td>------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>Felderer, Astrid</td>
<td>O–2203–03</td>
</tr>
<tr>
<td>Feldman Daniel</td>
<td>O–1115–06</td>
</tr>
<tr>
<td>Feller Christian</td>
<td>P–3325–02</td>
</tr>
<tr>
<td>Fellous Jean–Louis</td>
<td>K–1105a–01</td>
</tr>
<tr>
<td>Feng, Y.</td>
<td>P–2207–05</td>
</tr>
<tr>
<td>Féral, Jean–Pierre</td>
<td>P2209–10</td>
</tr>
<tr>
<td>Ferdous, Nafisa</td>
<td>P–4414–09</td>
</tr>
<tr>
<td>Fereday David</td>
<td>P–1117–33</td>
</tr>
<tr>
<td>Fernandes Katia</td>
<td>O–1117–02, K–3311–01</td>
</tr>
<tr>
<td>Fernandez Milan Blanca</td>
<td>O–4417–01, P–4405–03</td>
</tr>
<tr>
<td>Fernandez Poulussen Daniel</td>
<td>O–3307–03</td>
</tr>
<tr>
<td>Fernandez–Cortes A</td>
<td>P–1115–01</td>
</tr>
<tr>
<td>Fernandez C.</td>
<td>O–3326–03</td>
</tr>
<tr>
<td>Fernandez Danai</td>
<td>P–2219–03</td>
</tr>
<tr>
<td>Fernandez Sara</td>
<td>O–2212b–03</td>
</tr>
<tr>
<td>Ferraz Rodrigo</td>
<td>P–2214–06</td>
</tr>
<tr>
<td>Ferreira, Leila Da Costa</td>
<td>P–3311–03</td>
</tr>
<tr>
<td>Ferreira Felipe</td>
<td>O–2219–07</td>
</tr>
<tr>
<td>Ferréol, Martial</td>
<td>P–2235–04</td>
</tr>
<tr>
<td>Ferron Bruno</td>
<td>O–1110–04</td>
</tr>
<tr>
<td>Ferrusquia–Villafranca Ismael</td>
<td>P–1101–01</td>
</tr>
<tr>
<td>Fetsis Panagiotis</td>
<td>P–3315–07</td>
</tr>
<tr>
<td>Fettweis Xavier</td>
<td>P–1112–01</td>
</tr>
<tr>
<td>Fеulner, Georg</td>
<td>O–1110–03</td>
</tr>
<tr>
<td>Feumba Rodrigue Aimé</td>
<td>P–3330–26</td>
</tr>
<tr>
<td>Fghire Rachid</td>
<td>P–2225–02</td>
</tr>
<tr>
<td>Ficarelli, Paolo</td>
<td>P–3320–24</td>
</tr>
<tr>
<td>Fichet, Louis–Vincent</td>
<td>O–2215–03</td>
</tr>
<tr>
<td>Ficklin Lisa</td>
<td>P–4406–03</td>
</tr>
</tbody>
</table>

**Figueroa–Aguilar, Gloria (P–1121–08)**

**Figueroa Aurelia (O–3316–02)**

**Filatova, Tatiana (P–3322–06)**

**Filipsson Helena (K–1103–01)**

**Filizola Naziano (K–1119a–02, P–1119–16)**

**Fily Michel (P–1107–05)**

**Fink Andrea H (P–1117–41)**

**Fiogbe D. Emile (P–1117–44)**

**Firth J. (K–L4.2–02)**

**Fischedick Manfred (O–L3.3–02, K–3305–02)**

**Fischer, Erich (O–1113–01, P–1118–06, P–2203–03)**

**Fisher James (O–1116–02)**

**Fiske Greg (P–2214–01)**

**Flachsland Christian (P–4409–15)**

**Flahault Antoine (P–3325–06)**

**Flamand Claude (O–2226–02)**

**Flamant Cyrille (P–3330–46, P–3330–29)**

**Flanner M (O–1122–06)**

**Flaud Jean–Marie (P–1105–19)**

**Fleitmann Dominik (P–3326–05, K–3326–02)**

**Fleurbaey Marc (P–4412–05, P–3322–03, K–4412–01)**

**Florenzano Assunta (O–2241–05)**

**Flores Tenorio Pedro (P–2214–07)**

**Flörke, Martina (P–2205–11)**

**Fløttum Kjersti (O–2236–05)**

**Floury Mathieu (P–2235–04)**

**Foden Wendy (K–L3.4–01, O–4418b–01, P–2214–08)**

**Fodha, Mouez (K–3308–02)**

**Foelsche Ulrich (P–1105–09, P–1105–18)**

**Foerch Wiebke (O–4414–02, O–2236–02)**

**Foerch Wiebke (O–4414–02, O–2236–02)**

**Fogwill Christopher (P–1107–06)**

**Folberth Christian (P–2223–07)**

**Folhes Ricardo (P–2236–08)**
## INDEX OF AUTHORS

<table>
<thead>
<tr>
<th>Authors</th>
<th>Index Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fomba Emmanuel Mbebeb</td>
<td>O-3316-03</td>
</tr>
<tr>
<td>Fontaine Bernard</td>
<td>P-1113-18</td>
</tr>
<tr>
<td>Fontana Alessandro</td>
<td>P-3326-13</td>
</tr>
<tr>
<td>Fonta William</td>
<td>P-3330-38, P-2204-02</td>
</tr>
<tr>
<td>Forbes Alistair</td>
<td>P-1105-11</td>
</tr>
<tr>
<td>Forbes Cherie</td>
<td>P-4407-01</td>
</tr>
<tr>
<td>Ford James</td>
<td>O-3312-01, P-3326-02, K-3341-01, P-3321-15</td>
</tr>
<tr>
<td>Foret Gilles</td>
<td>O-2205-03</td>
</tr>
<tr>
<td>Forryan Alex</td>
<td>P-1113-05</td>
</tr>
<tr>
<td>Forsell, Nicklas</td>
<td>O-4402b-01, O-2218-01</td>
</tr>
<tr>
<td>Förster Johannes</td>
<td>K-2220-02</td>
</tr>
<tr>
<td>Fort Monique</td>
<td>P-2211-01</td>
</tr>
<tr>
<td>Fossa Riglos Maria Florencia</td>
<td>P-4417-02</td>
</tr>
<tr>
<td>Fournier Marie</td>
<td>P-3312-09, O-3337-02</td>
</tr>
<tr>
<td>Fowe Tazen</td>
<td>P-2212a-05</td>
</tr>
<tr>
<td>Fox Nicolette</td>
<td>P-4413-05</td>
</tr>
<tr>
<td>Fox Tom</td>
<td>K-L3.5-05</td>
</tr>
<tr>
<td>Foyer Jean</td>
<td>K-4411-01</td>
</tr>
<tr>
<td>Fracalanza, Paulo Sérgio</td>
<td>P-2240-07</td>
</tr>
<tr>
<td>Fraizy Pascal</td>
<td>K-1119a-02</td>
</tr>
<tr>
<td>Francisco Joseph S.</td>
<td>P-2245-07</td>
</tr>
<tr>
<td>Francois Dufois</td>
<td>P-1111-12</td>
</tr>
<tr>
<td>Francois Hugues</td>
<td>O-2211-04</td>
</tr>
<tr>
<td>Francois Louis</td>
<td>P-2215-03, P-2202-03</td>
</tr>
<tr>
<td>Frangoulis Constantin</td>
<td>P-2207-03</td>
</tr>
<tr>
<td>Frankl Paolo</td>
<td>K-3302-02</td>
</tr>
<tr>
<td>Franks, Max</td>
<td>P-3308-01, K-4405-01, K-3308-03</td>
</tr>
<tr>
<td>Frantzkeskaki Niki</td>
<td>P-4409-13</td>
</tr>
<tr>
<td>Freer-Smith Peter</td>
<td>K-L3.5-05</td>
</tr>
<tr>
<td>Freije, Ruben</td>
<td>P-1110-02</td>
</tr>
<tr>
<td>Freitas, M</td>
<td>P-2212b-02</td>
</tr>
<tr>
<td>Freitas Fabiana</td>
<td>P-4409-22</td>
</tr>
<tr>
<td>Frélichová Jana</td>
<td>O-2220-01</td>
</tr>
<tr>
<td>French John</td>
<td>P-1108-08</td>
</tr>
<tr>
<td>Freund James</td>
<td>P-4414-05</td>
</tr>
<tr>
<td>Freyberg, Chris</td>
<td>P-2204-07</td>
</tr>
<tr>
<td>Freychet Nicolas</td>
<td>P-1113-05</td>
</tr>
<tr>
<td>Fricko, Oliver</td>
<td>O-2218-01</td>
</tr>
<tr>
<td>Frieckenhaus Stephan</td>
<td>O-2207-01</td>
</tr>
<tr>
<td>Friedl-Vallon, Felix</td>
<td>P-1108-06</td>
</tr>
<tr>
<td>Friedlingstein Pierre</td>
<td>K-L2.2-02, K-1116-02, O-2217-02, P-1114-11, O-2204-05</td>
</tr>
<tr>
<td>Frieler, Katja</td>
<td>P-2223-03, P-2203-03, P-2205-11</td>
</tr>
<tr>
<td>Frimpong Kwasi</td>
<td>P-3330-27</td>
</tr>
<tr>
<td>Frisk Tom</td>
<td>P-3313-02</td>
</tr>
<tr>
<td>Fritz, Oliver</td>
<td>O-2203-03</td>
</tr>
<tr>
<td>Fritzler Johannes</td>
<td>P-1105-18</td>
</tr>
<tr>
<td>Froelicher Thomas</td>
<td>K-2209-02, P-1114-04</td>
</tr>
<tr>
<td>Fromard François</td>
<td>P-2210-02</td>
</tr>
<tr>
<td>Fromin Nathalie</td>
<td>P-2214-09</td>
</tr>
<tr>
<td>Frossard V</td>
<td>K-1101-03</td>
</tr>
<tr>
<td>Frumhoff Peter</td>
<td>P-4412-02, P-4412-07, P-2204-06, P-4412-01, P-4412-06</td>
</tr>
<tr>
<td>Fry M</td>
<td>K-3330b-02</td>
</tr>
<tr>
<td>Fuchs Markus</td>
<td>P-1102-07</td>
</tr>
<tr>
<td>Fuchs Markus</td>
<td>P-3312-09</td>
</tr>
<tr>
<td>Fu Congbin</td>
<td>K-3313-01</td>
</tr>
<tr>
<td>Fuenfgeld Hartmut</td>
<td>O-3313-03</td>
</tr>
<tr>
<td>Fuentes, Andres</td>
<td>P-2242-02</td>
</tr>
<tr>
<td>Fuentes, Gabriela</td>
<td>P-2219-03</td>
</tr>
<tr>
<td>Fuentes, Gabriela</td>
<td>P-2219-03</td>
</tr>
<tr>
<td>Fuentevilla Cristián</td>
<td>P-2238-05</td>
</tr>
<tr>
<td>Fuglestvedt Jan Sigurd</td>
<td>P-1114-10</td>
</tr>
<tr>
<td>Fujigaki Yuko</td>
<td>P-2202-02, P-2240-15</td>
</tr>
<tr>
<td>Fukushi Kensuke</td>
<td>P-4419-01</td>
</tr>
<tr>
<td>Fulton Elizabeth</td>
<td>P-1114-13</td>
</tr>
</tbody>
</table>
Galop Didier (O-2210-03)
Galvão, Antonio Carlos Filgueira (O-3317-02)
Gálvez, C (P-1119-13)
Galvin Kathleen (K-2224-01)
Galy-Lacaux Corinne (O-3318-02)
Gama–Castro Jorge (P-1101-01)
Gammage Louise (P-4407-02)
Ganachaud Alexandre (O-1110-01)
Gandiglia M. (P-3302-07)
Ganten, Detlev (P-3325-06)
Gantois, Marie (P-4415-02)
Gao Jing (O-1102-06)
Garba Zibo (P-3330-01)
Garbe Christoph (O-1115-04)
García De Cortazar–Atauri Inaki (P-2224-21, K-2218-03)
García–Anton E (P-1115-01)
García–Ibáñez Maribel I. (O-1110-04)
García–Launay Florence (P-2218-05)
García–Robledo Emilio (O-1110-05)
Garcia, Marta (P-1101-06)
Garcia, Rocio (O-4417-03)
Garcia Carlos (P-2230-02)
Garcin Helène (O-3325b-02)
Garcin Manuel (P-2210-03)
Garçon Véronique (O-1115-04, P-3302-01, O-1110-05)
Gardel Antoine (P-2210-02)
Garg Amit (P-3342-04, O-3316-06)
Gargiulo M. (O-3322b-01)
Garivait Savitri (P-3305-06)
Garnett Mark (O-1116-02)
Garnett Tara (O-3320-01)
Garnier Anne (O-3301-02)
Garnier Patricia (K-1116-03)
<table>
<thead>
<tr>
<th>Author Name</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Garny, Hella</td>
<td>O-1108-05</td>
</tr>
<tr>
<td>Carrec Cecilia</td>
<td>P-1105-14</td>
</tr>
<tr>
<td>Garren Sandra</td>
<td>P-3311-10</td>
</tr>
<tr>
<td>Garrigues, Sebastien</td>
<td>P-1115-06</td>
</tr>
<tr>
<td>Garschagen, Matthias</td>
<td>O-2203-02, P-2204-15, P-2236-09, O-2236-03</td>
</tr>
<tr>
<td>Garzoli Silvia</td>
<td>O-1110-02</td>
</tr>
<tr>
<td>Gascuel–Oudox Chantal</td>
<td>P-2224-03, P-2224-04</td>
</tr>
<tr>
<td>Gaspard Romain</td>
<td>P-2215-03</td>
</tr>
<tr>
<td>Gaspar Philippe</td>
<td>O-2209-01</td>
</tr>
<tr>
<td>Gasser Thomas</td>
<td>K-L2.2-02, P-3307-01, P-1116-06</td>
</tr>
<tr>
<td>Gatebe, Charles</td>
<td>O-1116-03</td>
</tr>
<tr>
<td>Gatien–Tournant Amandine</td>
<td>P-3312-09</td>
</tr>
<tr>
<td>Gattuso Jean–Pierre</td>
<td>K-2207-01, K-L1.3-01</td>
</tr>
<tr>
<td>Gatune Julius</td>
<td>O-3329-06</td>
</tr>
<tr>
<td>Gauffreateau Arnaud</td>
<td>P-2224-07</td>
</tr>
<tr>
<td>Gauquelin T.</td>
<td>O-3326-03</td>
</tr>
<tr>
<td>Gauss Michael</td>
<td>O-2205-03</td>
</tr>
<tr>
<td>Gauthier Caroline</td>
<td>P-1102-07</td>
</tr>
<tr>
<td>Gautier, Elsa</td>
<td>O-1103-03, O-1103-04</td>
</tr>
<tr>
<td>Gaye Amadou</td>
<td>P-3330-75, P-3330-13</td>
</tr>
<tr>
<td>Gaye Amadou Thierno</td>
<td>P-3330-18, P-2217-28</td>
</tr>
<tr>
<td>Gazal, Kathryn</td>
<td>P-2213-01</td>
</tr>
<tr>
<td>Gazal Rico</td>
<td>P-2213-01</td>
</tr>
<tr>
<td>Gca Izquierdo Guillermo</td>
<td>P-3326-04</td>
</tr>
<tr>
<td>Geall Sam</td>
<td>O-3333-02</td>
</tr>
<tr>
<td>Gehring Christoph</td>
<td>P-1117-31</td>
</tr>
<tr>
<td>Gemeda Adugna</td>
<td>P-3330-31</td>
</tr>
<tr>
<td>Gemenne Francois</td>
<td>O-2241-04</td>
</tr>
<tr>
<td>Gemenne Francois</td>
<td>O-2242-02, O-2242-03</td>
</tr>
<tr>
<td>Gena Carla Corrêa Costa</td>
<td>P-2240-22</td>
</tr>
<tr>
<td>Génard A.-C.</td>
<td>O-3326-03</td>
</tr>
<tr>
<td>Genthon Christophe</td>
<td>P-1107-07, P-1107-05</td>
</tr>
<tr>
<td>George–Marcelpoil Emmanuelle</td>
<td>O-2211-04</td>
</tr>
<tr>
<td>George Melikadze</td>
<td>P-2212a-06, O-3336-01</td>
</tr>
<tr>
<td>Georgiou Katerina</td>
<td>P-1116-07</td>
</tr>
<tr>
<td>Gérard, Françoise</td>
<td>P-3330-32</td>
</tr>
<tr>
<td>Gerardo Sanchez</td>
<td>P-3337-03, O-1121-01, P-1123-08</td>
</tr>
<tr>
<td>Géraud Magrin</td>
<td>P-2222-05</td>
</tr>
<tr>
<td>Gerbig Christoph</td>
<td>P-1105-19, O-1115-02</td>
</tr>
<tr>
<td>Gerdes Rüdiger</td>
<td>O-1112-02</td>
</tr>
<tr>
<td>Géron Amandine</td>
<td>P-2218-01</td>
</tr>
<tr>
<td>Geronimo R</td>
<td>P-2201-03</td>
</tr>
<tr>
<td>Gerten Dieter</td>
<td>P-2212b-06, P-2223-07, K-L1.2-03</td>
</tr>
<tr>
<td>Gesta, Mathieu</td>
<td>O-3327-02</td>
</tr>
<tr>
<td>Geyer Mikhail</td>
<td>P-1107-15</td>
</tr>
<tr>
<td>Chahreman Nozar</td>
<td>P-2201-02, P-2245-02</td>
</tr>
<tr>
<td>Chale, Rupendra</td>
<td>P-2214-02</td>
</tr>
<tr>
<td>Gharbaoui Dalila</td>
<td>O-2242-07</td>
</tr>
<tr>
<td>Gherardi Jeanne</td>
<td>O-1102-09</td>
</tr>
<tr>
<td>Ghersi Frédéric</td>
<td>O-4406a-01</td>
</tr>
<tr>
<td>Gheusi, François</td>
<td>P-1115-12, P-1115-03</td>
</tr>
<tr>
<td>Ghimire Jiwnath</td>
<td>O-4418-10</td>
</tr>
<tr>
<td>Ghosh Aditya</td>
<td>O-3324-04</td>
</tr>
<tr>
<td>Ghosh Biplab</td>
<td>P-2243-06</td>
</tr>
<tr>
<td>Ghosh Tuhin</td>
<td>P-2217-10</td>
</tr>
<tr>
<td>Ghude Sachin</td>
<td>O-1121-04</td>
</tr>
<tr>
<td>Giacona Florie</td>
<td>O-1101-04</td>
</tr>
<tr>
<td>Giannakourou Antonia</td>
<td>P-2207-03</td>
</tr>
<tr>
<td>Giannini Alessandra</td>
<td>O-1102-01, O-1113-04, O-1117-02</td>
</tr>
<tr>
<td>Giannini Valentina</td>
<td>P-3312-20, P-4418-11</td>
</tr>
<tr>
<td>Giannoulaki, Marianna</td>
<td>P-2209-09</td>
</tr>
<tr>
<td>Gibeins Jonathan</td>
<td>O-3307-01 (part2)</td>
</tr>
<tr>
<td>Gielen, Bert</td>
<td>P-1115-07</td>
</tr>
<tr>
<td>Giguet–Covex C</td>
<td>K-1101-03</td>
</tr>
</tbody>
</table>
INDEX OF AUTHORS

Goginashvili Mariami (P-2244-03)
Gogou Alexandra (P-3326-05, O-2241-05)
Gohin Francis (P-1110-03)
Golaz Valérie (P-2216-05)
Golden Denise (O-2238-03)
Goldringer Isabelle (P-2224-07)
Goldstein Josh (K-4418a-01)
Golledge, Nicholas (P-1107-06)
Collins Douglas (O-3320-01)
Coloub P. (P-1105-03)
Gomez Céline (P-1111-10)
Gond Valery (P-2215-10, O-2215-01)
Gonzales Carrasco Ana Lía (P-2212b-12, P-3313-07)
Gonzales Iwanciw Javier (P-4407-03)
Goodhew, Julie (P-3316-05)
Good Peter (P-1116-03, P-3330-68)
Goosse Hugues (K-1103-01)
Gordard Russell (K-2214-02)
Gordon, Arnold (O-1110-01)
Gordon Margaret (P-1117-33)
Gorgues Thomas (O-2209-01, P2209-01)
Gorin Arnaud (P-1121-06)
Gorin Coraline (O-4411-06)
Gosling Simon (P-2205-11, P-3321-04)
Gossart Cedric (P-3305-12)
Gosset Marielle (P-3330-33, P-3330-34)
Goswami P (P-1113-17)
Gouda K C (P-1113-17, P-1117-05)
Gough Claire (P-3307-09)
Goula Bi Tié Albert1 (P-3330-16)
INDEX OF AUTHORS

Coulard Françoise (P-2212b-07)
Courtois–Fleury Sylvie (P-2215-03, P-3331-01, P-2216-03)
Coutouly Jean Pascal (P-2224–21)
Couvela Celia (O-2245–02, O–1102–08)
Goyal R.s. (P–3321–05)
Goyette Stephane (P-2211–03)
Gozo Emilio (P-2217–30, P–1102–04)
Grab Stefan (P-2223–05, P-2224–19, O–1117–05)
Gracie Renata (O–4418b–02)
Graff–Zivin, Joshua (P-2240–06)
Graham Hilary (P–3321–17)
Grabow Bernd (P-2239–05)
Cranadillo Jessie (O–4406b–04)
Cranat Margaux (O–3341–05)
Grandcolas Philippe (P–2214–18)
Grandjean Gilles (P-2211–01, K–2211–01)
Grange Julie (O–2207–03)
Grangeon Jean–Paul (O–1111a–01)
Granier Claire (P–1114–08)
Grard Pierre (P–2215–08)
Grassi Giacomo (P–2217–23)
Grauert Marianne (O–2230–04)
Graveline Nina (P–2224–08)
Gravelle Médéric (O–1111b–03)
Grazzi Fabio (O–4406a–02)
Graziosi, Francesco (O–1115–05)
Green Colin (O–2210–02)
Green Manfred (O–3321–05)
Greenough Karen (P–3330–38)
Green Rosemary (O–2226–05)
Gregg Jay (P–4402–07)
Gregory Jonathan (O–1107–02, O–2245–03)
Grelet Jacques (O–1110–05)
Grémont Marine (P–2211–01, P–2224–08)
Greuell Wouter (P–2205–09)
Griffies Stephen (P–1106–04)
Griffin Elizabeth (P–1102–06)
Griffith Corrie (P–4415–04)
Grillakis Manolis (O–2205–04, P–2204–14)
Grippa Manuela (P–3330–65, K–3330a–01, P–3330–30,
P–3330–35, O–3330b–02)
Gritten, David (O–2220–02)
Groenendijk Margriet (O–2217–02)
Groner Vivienne (K–1101–02)
Groot, Annemarie (P–4418–16)
Gros–Desormeaux Jean–Raphaël (P–2236–10)
Grosjean Godefroy (O–4420b–02, P–3339–01)
Grosse, Guido (K–1116–02)
Grossi, Claudia (P–2217–21, P–1115–02, P–1123–02)
Grossi Carlota (O–2231–02, P–1115–01)
Grossi Claudia (P–1116–08)
Grosso Olivier (P–1111–04, P–1111–02)
Gros Valérie (P–1115–15)
Grottera Carolina (O–4411–05)
Grouillet, Benjamin (P–2212b–05)
Grove–Smith Jessica (P–3305–07)
Grover, O. (P–1119–13)
Grubb Michael (K–L3.1–01, P–3321–17, O–4420b–01,
K–3304–02, K–2237b–01)
Gruber Nicolas (P–1114–05)
Grubler Arnulf (K–3315–02)
Guajardo Ramírez Nadia (P–3315–04)
Gualdi, Silvio (O–1113–06)
Guan Kaiyu (K–3330b–01)
Guardia, Jose (P–3312–18)
Guedes Gilvan (P–2233–01, P–2240–08, P–4418–02)
Guégan Jean–François (O–2226–01)
Guélar Cissé (P-3328-19)
Guemas, Virginie (P-1111-09)
Guemri Ali (P-1105-14)
Guérin Emmanuel (K-4402b-02)
Guesnerie, Roger (K-2237b-02)
Guevara, Ramon (P-2224-26)
Guez, Lionel (P-1108-03)
Gu O Xiao (O-33322b-05, P-3322-05)
Guibal, Frederic (P-3326-04)
Guichard Françoise (P-3330-36, P-3330-48)
Guichon Dominique (P-1121-06)
Guidini Lopes Ivã (P-2213-03)
Guidi T. Colitilde (P-1117-44)
Guie Cécile (K-1106-02, O-3326-02)
Guilherme Carvalho (O-3304-03)
Guillaume, Joseph (P-3322-06)
Guillaumont Patrick (P-4401-02, O-4401-02)
Guillaumot Laurent (O-1111a-01)
Guilles Da Conceição Marcela Cardoso (O-1119b-02)
Guilyardi Eric (P-1102-17, K-1111a-03, K-L1.5-03)
Guimberteau Matthieu (O-1119b-01)
Guiot Joel (O-1101-01, P-3326-04, O-3326-04)
Guissé Aliou (O-3331-02)
Guiter Frédéric (O-1101-03)
Guivarch Celine (O-2236-01, P-3307-01)
Gulev Sergey (P-1106-01)
Gunawan Dodo (P-1117-28)
Gundogan Arif Cem (P-4410-07, O-3311-04)
Gunter Zeug (O-3337-04)
Gupta Aarti (K-4409b-02)
Gupta Akilesh (P-4418-27)
Gupta Arnab (P-2225-05)
Gupta Vijaya (O-2238-01)

Gurdak, Jason (P-2212a-10)
Gurjar Bhola Ram (P-1114-06)
Gurney Kevin (P-1114-11)
Gusti, Mykola (O-2218-01)
Gutierrez Aguilar Dimitri (P-1119-18, P-1116-09)
Gutierrez Alvaro G. (P-2205-03)
Gutierrez Juan (O-2230-06)
Gütschow Johannes (P-4412-03, O-4412-01)
Güttler, Ivan (P-1113-12)
Guttu Sigmund (K-3318-01)
Guy Brendan (O-4410-01)
Guyot Jean–Loup (O-1119b-01, K-1119a-02, P-1119-16, P-1119-12, P-1119-03, P-1119-13)
Gwambene Brown (O-3325a-03)

H
H. Maleki Badjana (P-3330-51)
Ha Duong Minh (O-4419-03)
Ha-Duong Minh (P-3303-16)
Haas Jean Nicolas (P-1101-04)
Habets Florence (P-2212b-08, O-1119b-04)
Habib, Shahid (O-1116-03)
Habilov Mushfig (P-4418-29)
Hackett, Edward J. (P-4418-12)
Hackmann Heide (K-4417-01)
Haddadimoghaddam Kouros (P-2226-05)
Haddam, Naoufel (O-1110-05)
Haddeland Ingjerd (P-2205-11)
Haensler Andreas (P-3330-55)
Hafidi Majida (P-3326-03)
Hagemann, Markus (O-4402b-01, O-4412-01)
Hagemann Stefan (P-3330-55)
Hagen Achim (P-4409-12)
Hahoo Henry (P-2238-08)
<table>
<thead>
<tr>
<th>Author</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haider Wolfgang</td>
<td>O-2216-01</td>
</tr>
<tr>
<td>Hallesilassie Wondimu</td>
<td>P-3328-05</td>
</tr>
<tr>
<td>Haines Andrew</td>
<td>O-2226-05, P-3321-17</td>
</tr>
<tr>
<td>Hajat Shakoor</td>
<td>P-1121-11</td>
</tr>
<tr>
<td>Hajdas I.</td>
<td>P-1101-04</td>
</tr>
<tr>
<td>Ha Jong sik</td>
<td>P-3321-06</td>
</tr>
<tr>
<td>Hales Simon</td>
<td>O-1111a-01, O-3321-03</td>
</tr>
<tr>
<td>Halewood Michael</td>
<td>P-3311-04</td>
</tr>
<tr>
<td>Haley, Ben</td>
<td>P-4402-15</td>
</tr>
<tr>
<td>Halilu S. Ahmad</td>
<td>P-2217-18</td>
</tr>
<tr>
<td>Hallegatte Stéphane</td>
<td>O-2210-02, K-4406b-01, O-4406b-02, K-2234-03, P-4415-07, P-3312-25</td>
</tr>
<tr>
<td>Hall Jim</td>
<td>O-4408-01</td>
</tr>
<tr>
<td>Hama Angela Michiko</td>
<td>O-2233-04, O-2203-03</td>
</tr>
<tr>
<td>Hamam Yskandar</td>
<td>P-3328-06</td>
</tr>
<tr>
<td>Hamaoui-Laguay Lynda</td>
<td>O-1121-05</td>
</tr>
<tr>
<td>Hambuckers Alain</td>
<td>P-2202-03</td>
</tr>
<tr>
<td>Hamburg, Steven</td>
<td>P-4418-25</td>
</tr>
<tr>
<td>Hamdi–Cherif Meriem</td>
<td>O-3333-04, P-4402-08</td>
</tr>
<tr>
<td>Hamel Perrine</td>
<td>K-4418a-01</td>
</tr>
<tr>
<td>Hamerlynck, Olivier</td>
<td>P-2219-10</td>
</tr>
<tr>
<td>Hampton, Stephanie</td>
<td>P-4418-12</td>
</tr>
<tr>
<td>Hampton John</td>
<td>O-2209-01</td>
</tr>
<tr>
<td>Hamza-Goodacre Dan</td>
<td>P-4406-04</td>
</tr>
<tr>
<td>Han W (K-L1.5-02)</td>
<td></td>
</tr>
<tr>
<td>Hanaki Nobuyuki</td>
<td>O-3326-04</td>
</tr>
<tr>
<td>Hanasaki Naota</td>
<td>P-2204-17</td>
</tr>
<tr>
<td>Hanich Lahoucine</td>
<td>P-2211-04</td>
</tr>
<tr>
<td>Hannart Alexis</td>
<td>O-1102-02</td>
</tr>
<tr>
<td>Hannon Matthew</td>
<td>K-3315-01, P-3315-08</td>
</tr>
<tr>
<td>Hansen, Gerrit</td>
<td>K-1118a-02</td>
</tr>
<tr>
<td>Hansen, Philippe</td>
<td>P-3302-02</td>
</tr>
<tr>
<td>Hansson Hans–Christen</td>
<td>O-1102-03</td>
</tr>
<tr>
<td>Hansson Lina</td>
<td>P-2207-02</td>
</tr>
<tr>
<td>Han Wei Qin</td>
<td>K-1111a-02</td>
</tr>
<tr>
<td>Hao Wei Min</td>
<td>O-1114-05</td>
</tr>
<tr>
<td>Hao Zhixin</td>
<td>P-1117-12</td>
</tr>
<tr>
<td>Haque Anika N.</td>
<td>P-2239-06</td>
</tr>
<tr>
<td>Harden Jennifer</td>
<td>K-1116-02</td>
</tr>
<tr>
<td>Hardy Jeff</td>
<td>K-3304-02</td>
</tr>
<tr>
<td>Hare Bill</td>
<td>O-4412-01, O-4406b-04</td>
</tr>
<tr>
<td>Harford Deborah</td>
<td>P-2243-07</td>
</tr>
<tr>
<td>Harper, Sherilee</td>
<td>P-3321-15</td>
</tr>
<tr>
<td>Harrington Luke</td>
<td>P-1119-07</td>
</tr>
<tr>
<td>Harrison, Stephan</td>
<td>P-2236-17</td>
</tr>
<tr>
<td>Harrison Matthew</td>
<td>K-2223-02</td>
</tr>
<tr>
<td>Harrison Sandy</td>
<td>K-1105b-01, O-1102-05</td>
</tr>
<tr>
<td>Harrould–Koliev Ellycia</td>
<td>P-2207-01, O-2207-05</td>
</tr>
<tr>
<td>Harrisson Paula</td>
<td>O-2204-01</td>
</tr>
<tr>
<td>Hartley Ian</td>
<td>P-1116-14, O-1116-02, P-2215-04</td>
</tr>
<tr>
<td>Hartmann Jens</td>
<td>O-3307-01 (part1)</td>
</tr>
<tr>
<td>Haruna, Akiko</td>
<td>O-2217-01, P-2217-12</td>
</tr>
<tr>
<td>Harvey Blaze</td>
<td>O-4414-02</td>
</tr>
<tr>
<td>Harvey Jeff A.</td>
<td>P-2214-13</td>
</tr>
<tr>
<td>Harvey Pamela</td>
<td>O-1117-05</td>
</tr>
<tr>
<td>Hassouna Melynda</td>
<td>P-2218-05</td>
</tr>
<tr>
<td>Hatté Christine</td>
<td>P-1102-07</td>
</tr>
<tr>
<td>Hauchecorne Alain</td>
<td>P-1105-03, O-1108-03, P-1108-04, P-1108-01, O-1108-02</td>
</tr>
<tr>
<td>Hauser Mathias</td>
<td>O-1118a-03</td>
</tr>
<tr>
<td>Haustein, Karsten</td>
<td>P-2240-17</td>
</tr>
<tr>
<td>Hautière Nicolas</td>
<td>K-3336-02</td>
</tr>
<tr>
<td>Havlik Petr</td>
<td>K-2217-22, O-2218-01, K-2217-03, O-2236-02, P-2215-07, P-3307-02</td>
</tr>
<tr>
<td>Hawkins Ed</td>
<td>K-1117-01, O-1113-01, P-1102-08</td>
</tr>
<tr>
<td>Hawkins Linnia</td>
<td>O-2245-04</td>
</tr>
<tr>
<td>Hawkins Sonja</td>
<td>O-4403-04</td>
</tr>
</tbody>
</table>
Hawthorne, David (O-4418a-02)
Haywood Alan (K-1102-02)
Hayna Lynn (P-1105-14)
Hazard Benoit (O-3329-03, P-3329-01)
Hazarika Nandita (P-1101-02)
Hazeleger Wilco (P-1123-174)
Heaviside, Clare (P-2204-06)
Heede Richard (K-4412-02, P-4412-01, O-1114-02)
Hegerl Gabriele (P-1118-02)
Hegger Dries (P-4407-04, P-3337-01, P-3312-09)
Hegre, Håvard (P-3340-01)
Heidinger Haline (P-1117-35)
Heinke, Jens (P-2212b-06, P-2205-11)
Heinrich Philippe (P-1108-01)
Heinze Christoph (O-1116-01)
Heinzeller Dominikus (P-1104-04)
Heitzig Jobst (P-4401-01)
Hélias Sandra (P-1111-04)
Helle, Julie (P-1115-12, P-1105-14)
Hellin Jon (P-2224-09)
Helmut Haberl (O-3316-01)
Hély Christelle (K-1101-01)
Hemani Chinmai (P-1123-06)
Hempelmann Nils (P-1118-04)
Hemstock Sarah (P-4413-04)
Henault Catherine (P-2218-05, P-2225-06)
Hendrickx Frédéric (K-2212b-03)
Henke, Carlos (P-2240-16)
Hennessy K (K-1111a-03, K-L1.5-03)
Henne Stephan (P-1114-01)
Henriques Melo–Santos Raquel (P-2240-09)
Henrot Alexandra–Jane (P-2202-03)
Henson, Stephanie (P-1117-13)
Hérault Bruno (O-2215-04)
Hérault Bruno (P-2215-03)
Herbreteau Vincent (P-4418-22)
Hermann, Albert (P2209-02)
Hermann Markus (P-1105-19)
Hermwille Lukas (P-4414-06, P-4409-29)
Hernandez–Carrasco Ismael (O-1115-04)
Hernandez, Francisco (O-1105b-02)
Hernandez Valeria (P-4417-02)
Herold Martin (K-L3.5-09, K-2218-01, O-2219-06, P-2219-05)
Herr, D (O-2207-05)
Herrmann François Richard (O-2226-04)
Hertzog, Albert (P-1108-03)
Hervé, Guibert (P-1117-07)
Hespanha, Stacy Rebich (P-4418-12)
Hess, Peter G. M. (P-1116-12)
Hewitson Bruce (O-2201-01)
Hicke Jeffrey (O-2245-04)
Hidalgo–Gonzalez, Patricia (O-2237b-03)
Hidalgo Julia (P-4415-07)
Hien Edmond (O-3325b-03)
Hiernaux Pierre (O-3330b-02)
Hiernaux Pierre (P-3330-65, P-3330-35)
Hik David (K-1112-03)
Hilaire Jérôme (O-3306-01)
Hilaire Kougebaegbede (P-3330-37)
Hilderink, H (P-3328-17)
Hill C. (K-L3.2-02)
Hillier, Jon (P-2218-02, P-2218-03)
Hilmi Karim (P-1110-01)
Hilmi Nathalie (P-2207-02)
Himmelsbach Iso (O-1101-04)
<table>
<thead>
<tr>
<th>Author Name</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hindmarsh, Richard</td>
<td>(P-3312-24)</td>
</tr>
<tr>
<td>Hingray Benoît</td>
<td>(K-2212b-03, O-2211-04)</td>
</tr>
<tr>
<td>Hinvi Cloud Lambert</td>
<td>(P-1117-44)</td>
</tr>
<tr>
<td>Hipel Keith W</td>
<td>(P-2225-19)</td>
</tr>
<tr>
<td>Hirayama Nagahisa</td>
<td>(P-3342-04)</td>
</tr>
<tr>
<td>Hiro M.</td>
<td>(K-L2.4-02)</td>
</tr>
<tr>
<td>Hirnsperger M.</td>
<td>(P-1101-04)</td>
</tr>
<tr>
<td>Hirschi Joel J. M.</td>
<td>(P-1113-05)</td>
</tr>
<tr>
<td>Hitayezu Patrick</td>
<td>(O-2240-03)</td>
</tr>
<tr>
<td>Hoang T.t.h</td>
<td>(P-1113-16)</td>
</tr>
<tr>
<td>Ho Chin Siong</td>
<td>(P-4414-07)</td>
</tr>
<tr>
<td>Hockley, Neal</td>
<td>(P-2219-07)</td>
</tr>
<tr>
<td>Hodgson Dominic</td>
<td>(P-1101-05)</td>
</tr>
<tr>
<td>Hodnebrog, Øivind</td>
<td>(O-1122-06, P-2205-06)</td>
</tr>
<tr>
<td>Hoegh–Guldberg Ove</td>
<td>(K-2207-02)</td>
</tr>
<tr>
<td>Hof Andries</td>
<td>(O-4402b-01, O-2237a-02)</td>
</tr>
<tr>
<td>Hoffmann, A.</td>
<td>(O-4418b-01)</td>
</tr>
<tr>
<td>Hoffmann, Marcia</td>
<td>(P-4405-03)</td>
</tr>
<tr>
<td>Hoffmann Matthew</td>
<td>(O-4410-01)</td>
</tr>
<tr>
<td>Hohl, Roman</td>
<td>(P-2233-03)</td>
</tr>
<tr>
<td>Hönne Niklas</td>
<td>(K-L2.2-03, O-4410-01, O-4402b-01, O-4412-01)</td>
</tr>
<tr>
<td>Hoibian, Thierry</td>
<td>(P-3342-02)</td>
</tr>
<tr>
<td>Hojjatollah Yazdanpanah</td>
<td>(P-2223-11)</td>
</tr>
<tr>
<td>Hole, D.</td>
<td>(O-4418b-01)</td>
</tr>
<tr>
<td>Holland, Mike</td>
<td>(O-1121-02)</td>
</tr>
<tr>
<td>Holland Elisabeth</td>
<td>(P-3320-14)</td>
</tr>
<tr>
<td>Hollesen Jørgen</td>
<td>(P-1116-17)</td>
</tr>
<tr>
<td>Holleau Nicolas</td>
<td>(O-1101-04)</td>
</tr>
<tr>
<td>Hollowed Anne</td>
<td>(P-2209-02)</td>
</tr>
<tr>
<td>Holman Ian</td>
<td>(O-2204-01)</td>
</tr>
<tr>
<td>Holmgren Karin</td>
<td>(O-2241-05)</td>
</tr>
<tr>
<td>Hölscher Katharina</td>
<td>(P-4409-13)</td>
</tr>
<tr>
<td>Holsman Kirstin</td>
<td>(P2209-02)</td>
</tr>
<tr>
<td>Holsten, Anne</td>
<td>(P-2226-02)</td>
</tr>
<tr>
<td>Holzer-Popp Thomas</td>
<td>(P-1105-04)</td>
</tr>
<tr>
<td>Homwood Stephen</td>
<td>(P-3313-03)</td>
</tr>
<tr>
<td>Honda Yasushi</td>
<td>(P-1121-07)</td>
</tr>
<tr>
<td>Honda Yasushi</td>
<td>(P-2204-17, O-3321-03)</td>
</tr>
<tr>
<td>Hondula David</td>
<td>(P-3321-04)</td>
</tr>
<tr>
<td>Hood, Christina</td>
<td>(P-3306-03)</td>
</tr>
<tr>
<td>Hoogenboom Gerrit</td>
<td>(P-2223-19)</td>
</tr>
<tr>
<td>Hook Jonathan</td>
<td>(K-2238-02)</td>
</tr>
<tr>
<td>Hope Chris</td>
<td>(O-3327-03, K-4420b-01)</td>
</tr>
<tr>
<td>Hopping, Kelly</td>
<td>(O-2211-01)</td>
</tr>
<tr>
<td>Horrocks Lisa</td>
<td>(P-4418-13)</td>
</tr>
<tr>
<td>Horton Joshua</td>
<td>(P-3301-03)</td>
</tr>
<tr>
<td>Hossain Faisal</td>
<td>(O-1111b-03, O-1111b-02)</td>
</tr>
<tr>
<td>Hossain Moazzem</td>
<td>(K-3332-02)</td>
</tr>
<tr>
<td>Hosseinpour, Farnaz</td>
<td>(O-1116-03)</td>
</tr>
<tr>
<td>Hou, Chaoping</td>
<td>(P-2240-23, P-3341-03)</td>
</tr>
<tr>
<td>Houessou Donald</td>
<td>(P-2243-14)</td>
</tr>
<tr>
<td>Houet Thomas</td>
<td>(P-2211-01, P-4415-07)</td>
</tr>
<tr>
<td>Houghton–Carr Helen</td>
<td>(K-3330b-02)</td>
</tr>
<tr>
<td>Houghton Richard A.</td>
<td>(O-1114-03)</td>
</tr>
<tr>
<td>Houinato Marcel</td>
<td>(P-2224-17)</td>
</tr>
<tr>
<td>Houibert Fanny</td>
<td>(O-1111b-01)</td>
</tr>
<tr>
<td>Houngninou Etienne</td>
<td>(P-3330-37)</td>
</tr>
<tr>
<td>Hounsou–Gbo Aubains</td>
<td>(O-1106-01)</td>
</tr>
<tr>
<td>Houot, Sabine</td>
<td>(P-1116-11)</td>
</tr>
<tr>
<td>Hourcade Jean–Charles</td>
<td>(K-L3.1-06, K-L4.1-01, P-4406-02, P-4402-03, O-4420b-01, K-2237b-01)</td>
</tr>
<tr>
<td>Hourdin Frédéric</td>
<td>(P-3330-29, P-3330-36, P-3330-18)</td>
</tr>
<tr>
<td>House Joanna</td>
<td>(P-2217-23, K-2217-01)</td>
</tr>
<tr>
<td>Hovelsrud Grete</td>
<td>(P-2239-07)</td>
</tr>
<tr>
<td>Hovi, Jon</td>
<td>(P-4409-36)</td>
</tr>
</tbody>
</table>
Howarth Candice (P-4409-14)
Howland Fanny (O-2225-01)
Hsu Angel (O-4410-01)
Hsu Huang—Hsiung (P-1113-05)
Hu, Dunxin (O-1110-01)
Hu, Shijian (O-1110-01)
Hu Aixue (P-1107-08)
Huang–Lachmann, Jo–Ting (P-4418-28)
Huang, F–M (P-3321–11)
Huang J. (K-L2.5-06)
Huang Mei (P-1117-14)
Huber, Veronika (P-2205-11)
Hubert Romain (P-4404-02, P-4404-01)
Huck Thierry (O-1110-04)
Hudson Paul (O-4408-02)
Hugelius, Gustaf (K-1116-02)
Huggel Christian (P-2211-12, P-4418-27, O-2211-02, K-1118a-02)
Hughes Alison (P-4402–16, O-4411-01)
Hugo Wim (O-1105b-03)
Huijtema Dave (O-3339-04, K-4409a-02)
Humpenoeder Florian (P-2217–13, P-2219-13, P-2218-06, O-2217-02)
Hungate Bruce (P-1116-13)
Hunsoo Choi (P-2243-05)
Hunt, Alistair (K-3309-01)
Hunter Alexnadra May (P-3301-04)
Huntingford Chris (O-1118a-02, P-2204-06, O-2244-01)
Huntley, B. (O-4418b–01)
Huntzinger, Deborah (P-1114-11)
Huppes Gjalt (K-4409b-04)
Huq Saleemul (P-1104-05, K-2239-02, O-2235-06)
Huret Nathalie (P-1108-04)
Husen Md Akbal (P-2214-10)
Hutton Jon (O-4418b-03)
Hyatt, Olivia (P-2204-07)
Hyder Pat (P-1106-03)
Hyman Glenn (P-2217-12)
Ianelli, James (P2209-02)
Ibiapina Izabel (P-2240-14)
Ibrahim Boubacar (P-3330–38, P-2212a-05)
Ibrahim Moussa (P-2212a-07)
Ichoku Charles (O-1116-03)
Idier Déborah (P-2210-04, P-4418-19)
Idris H (P-1111-11)
Iese Viliamu (P-2224–10, P-3320-14)
Iiyama, Miyuki (K-2218-02)
Ilieva Lili (P-2220-01)
Illig Serena (O-1115-04)
Illig Séréna (O-1110-05)
Imada Yukiko (O-1118b-04)
Ima Vieira (P-2236-08)
Imbert Daniel (O-2210-03)
Im Jungho (P-1117-20, P-2212a-23)
Ingram William (O-1118a-02)
Inoue, Makoto (K-1115-01)
Ionesco Dina (O-2242-06)
Ionescu, Artur (O-1114-04)
Ionescu A. (O-2231-02)
Iqbal Khurram (P-2216-06)
Isensee Kirsten (O-2207-05)
Iseri Yoshihiko (P-2204-17)
Isguder, Gulay (O-1110-05)
Ishii Atsushi (P-3301-08)
Ishii Masayoshi (O-1118b-04)
Ishizawa Misa (K-1115-01)
# INDEX OF AUTHORS

<table>
<thead>
<tr>
<th>Author Name</th>
<th>Index Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Islam, Gm Tarekul</td>
<td>(O-3341–03)</td>
</tr>
<tr>
<td>Islam Mohammad Mahmudul</td>
<td>(P-1113–06)</td>
</tr>
<tr>
<td>Islam Mohammad Mahmudul</td>
<td>(P-1117–15, P-2243–12)</td>
</tr>
<tr>
<td>Islam Naimul</td>
<td>(P-1117–15)</td>
</tr>
<tr>
<td>Islam Shahnila</td>
<td>(O-2236–02)</td>
</tr>
<tr>
<td>Islas Cortes Ivan</td>
<td>(O-4406a–02)</td>
</tr>
<tr>
<td>Ismail J</td>
<td>(P-1111–11)</td>
</tr>
<tr>
<td>Issiaka Savané</td>
<td>(P-3330–16, P-2212a–03, P-3330–41, P-3328–19, P-1102–12)</td>
</tr>
<tr>
<td>Ito Akihiko</td>
<td>(P-2204–17)</td>
</tr>
<tr>
<td>Itoh Sadahiko</td>
<td>(P-3342–04)</td>
</tr>
<tr>
<td>Ito Shin–Ichi</td>
<td>(K-2209–03)</td>
</tr>
<tr>
<td>Iversen, Colleen M</td>
<td>(P-1116–14)</td>
</tr>
<tr>
<td>Iversen Trond</td>
<td>(O-1102–03)</td>
</tr>
<tr>
<td>Ivins, Erik</td>
<td>(K-1107–01)</td>
</tr>
<tr>
<td>Ivory Sarah</td>
<td>(K-1101–01)</td>
</tr>
<tr>
<td>Ivy–Ochs Susan</td>
<td>(P-1101–05)</td>
</tr>
<tr>
<td>Iwase Kenta</td>
<td>(P-2204–17)</td>
</tr>
<tr>
<td>Izdebski Adam</td>
<td>(P-3326–05, K-3326–02, O-2241–05)</td>
</tr>
<tr>
<td>Izumi, K.</td>
<td>(O-1102–05)</td>
</tr>
<tr>
<td>J.o. Azeez</td>
<td>(P-2225–10)</td>
</tr>
<tr>
<td>Jaakkola Niko</td>
<td>(P-4412–02)</td>
</tr>
<tr>
<td>Jaccard, Samuel</td>
<td>(O-1110–05)</td>
</tr>
<tr>
<td>Jaccard Mark</td>
<td>(O-3322a–05)</td>
</tr>
<tr>
<td>Jaccard Samuel</td>
<td>(P-1102–10)</td>
</tr>
<tr>
<td>Jack Christopher</td>
<td>(P-4418–14)</td>
</tr>
<tr>
<td>Jackson, Mike</td>
<td>(P-1115–05)</td>
</tr>
<tr>
<td>Jacob Daniela</td>
<td>(K-2205–01, P-2231–01, O-2231–10)</td>
</tr>
<tr>
<td>Jacqué Marie</td>
<td>(P-3326–06)</td>
</tr>
<tr>
<td>Jacquemin Ingrid</td>
<td>(P-2202–03)</td>
</tr>
<tr>
<td>Jacquet, Laurent</td>
<td>(P-4415–02)</td>
</tr>
<tr>
<td>Jaeger Carlo</td>
<td>(O-3324–02, K-4405–04)</td>
</tr>
<tr>
<td>Jaeger Jill</td>
<td>(O-2204–01)</td>
</tr>
<tr>
<td>Jägermeyr Jonas</td>
<td>(K-L2.5–04, P-2212b–06)</td>
</tr>
<tr>
<td>Jahiel Michel</td>
<td>(O-2218–03)</td>
</tr>
<tr>
<td>Jain Atul</td>
<td>(P-1116–10)</td>
</tr>
<tr>
<td>Jakavula Zukisani</td>
<td>(P-4407–01)</td>
</tr>
<tr>
<td>Jakeman Anthony</td>
<td>(P-3322–06)</td>
</tr>
<tr>
<td>Jakob Michael</td>
<td>(P-4409–15, K-4406b–03)</td>
</tr>
<tr>
<td>Jalard Matthieu</td>
<td>(O-4420a–03)</td>
</tr>
<tr>
<td>Jalloh A.</td>
<td>(P-3330–47)</td>
</tr>
<tr>
<td>Janardanan, Rajesh</td>
<td>(K-1115–01)</td>
</tr>
<tr>
<td>Jandl Robert</td>
<td>(O-2203–03, O-2216–01)</td>
</tr>
<tr>
<td>Jane Glavan</td>
<td>(P-2245–03)</td>
</tr>
<tr>
<td>Janicot Serge</td>
<td>(P-3330–39, P-3330–36, P-3330–13)</td>
</tr>
<tr>
<td>Jannuzzi, Gilberto</td>
<td>(P-4402–04)</td>
</tr>
<tr>
<td>Janssen, P</td>
<td>(P-3328–17)</td>
</tr>
<tr>
<td>Janssens, Ivan</td>
<td>(P-1115–07)</td>
</tr>
<tr>
<td>Jansson Per–Erik</td>
<td>(P-1116–17)</td>
</tr>
<tr>
<td>Jans Wilma</td>
<td>(O-2204–04)</td>
</tr>
<tr>
<td>Jan Witajewski</td>
<td>(O-3305–03)</td>
</tr>
<tr>
<td>Janzen H.h.</td>
<td>(P-3320–15)</td>
</tr>
<tr>
<td>Jarlan Lionel</td>
<td>(P-2211–04)</td>
</tr>
<tr>
<td>Jarre, Astrid</td>
<td>(P-4407–02)</td>
</tr>
<tr>
<td>Jarvis Andrew</td>
<td>(O-2235–03, O-2225–01)</td>
</tr>
<tr>
<td>Jasanoff Sheila</td>
<td>(K-2241–01)</td>
</tr>
<tr>
<td>Jaskolski Tina</td>
<td>(P-1115–14)</td>
</tr>
<tr>
<td>Jassogne Laurenc</td>
<td>(P-2223–05, P-2225–11)</td>
</tr>
<tr>
<td>Jat Mi</td>
<td>(O-2235–03)</td>
</tr>
<tr>
<td>Jayanthi, M</td>
<td>(P-1104–02)</td>
</tr>
<tr>
<td>Jayet, Pierre–Alain</td>
<td>(P-2217–17, K-2218–03)</td>
</tr>
<tr>
<td>Jean Michel Taku</td>
<td>(P-3341–04)</td>
</tr>
<tr>
<td>Jeffery Mairi Louise</td>
<td>(P-4412–03, P-4412–08, O-4412–01)</td>
</tr>
<tr>
<td>Jeffress, Gary</td>
<td>(P-1107–14)</td>
</tr>
<tr>
<td>Jena Chinmay</td>
<td>(O-1121–04)</td>
</tr>
</tbody>
</table>
INDEX OF AUTHORS

Jenkins Katie (O-4408-01)
Jenny J.-P. (K-1101-03)
Jerez Sonia (P-3303-11, O-3303-01, P-2205-09)
Jeuffroy Marie-Hélène (P-2218-05)
Jewell Jessica (P-3306-02)
Jewell Jessica (O-3322b-06, P-4402-17)
Jewett Libby (P-2207-04)
Jewitt Debbie (P-4418-15)
Jha Chandan (P-2224-11)
Jia Censuo (K-3313-01)
Jian-Bin Huang (O-2205-02)
Jiang Jinhe (P-3305-08)
Jiang Kefun (K-L2.1-01, O-4414-05)
Jikun Huang (O-3309-02)
Jim C. Y. (P-2229-03)
Jimenez-Cisneros Blanca (K-2212a-03)
Jintiach Juan Carlos (O-2238-04)
Jockers, Pierre (P-3315-13)
Joeckel, Patrick (O-1108-05)
Joffre, Richard (P-3326-04, P-1115-06)
Johannessen, Truls (O-1115-01)
John Foran (P-4410-02)
Johnson Brian (O-1105b-05)
Johnson Eileen (P-1101-01)
Johnson Katie (P-4415-05)
Johnson Nils (O-4402a-01)
Johnsson, Filip (P-3305-13)
Johnston E (P-2201-03)
Johnston Josiah (P-1123-034)
Jolivet Vincent (P-4409-22)
Jomelli Vincent (P-2211-05, P-1101-05)
Jonas Zuuwe (P-2224-12)
Jones, Andrew (P-2218-07)

Jones, Anne (P-3330-57, O-3330b-03)
Jones, Bryan (P-2204-01)
Jones, Jeremy B. (P-1116-01)
Jones, Lindsey (O-2222-05)
Jones, Miranda (K-2209-02)
Jones, P (P-1102-08)
Jones, Richard (P-1107-06)
Jones Charles (P-1117-35)
Jones Chris (P-2217-07, P-1116-03, P-2218-09, P-3307-01)
Jones David (O-3307-03)
Jones James (O-2223-02, P-2223-07)
Jones Julia (P-2219-07)
Jones Kevin (O-3303-03)
Jones Laurence (O-2244-01)
Jones Richard (O-1118a-02)
Jonsson, Colleen (O-4418a-02)
Jordan Andy (K-4409a-02)
Jordan Osvaldo (P-3312-18)
Joseph Cahama (P-2228-014)
Joshi Anup (P-2214-01)
Joshi Bhagwati (P-3341-05)
Joshi Kamal Narain (P-2212a-08, O-4409-16)
Josiel Cunha (P-1123-14)
Josse Béatrice (O-2205-03)
Josse Patrick (P-1104-09, O-1119b-04)
Jossou Flandre (P-1105-14)
Jost Christine (P-4414-09, O-2236-02)
Joswiak Daniel R. (O-1102-06)
Jotzo Frank (O-3333-01)
Jouffe Yves (P-4413-01)
Jourdain Bruno (P-1107-05)
Jourdain Nicolas (O-L1.5-01, O-1111a-02)
## INDEX OF AUTHORS

<table>
<thead>
<tr>
<th>Name</th>
<th>Reference Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jourdan Christophe</td>
<td>(P-2218-01)</td>
</tr>
<tr>
<td>Jourdan Herve</td>
<td>(P-1111-10)</td>
</tr>
<tr>
<td>Joussaume Sylvie</td>
<td>(O-2202-03)</td>
</tr>
<tr>
<td>Jouvet Pierre-André</td>
<td>(P-4409-10)</td>
</tr>
<tr>
<td>Joy Murray</td>
<td>(O-4417-02)</td>
</tr>
<tr>
<td>Juarez M</td>
<td>(P-4414-21)</td>
</tr>
<tr>
<td>Juckes Martin</td>
<td>(P-4418-16)</td>
</tr>
<tr>
<td>Jullien Swen</td>
<td>(O-L1.5-01, O-1111a-02)</td>
</tr>
<tr>
<td>Juneng Liew</td>
<td>(P-1117-28)</td>
</tr>
<tr>
<td>Jung, W. S.</td>
<td>(P-2223-04)</td>
</tr>
<tr>
<td>Junpen, Agapol</td>
<td>(P-3305-06)</td>
</tr>
<tr>
<td>Junquas Clementine</td>
<td>(P-2211-06)</td>
</tr>
<tr>
<td>Justin, F.</td>
<td>(P-2212b-02)</td>
</tr>
<tr>
<td>Justin Sheffield</td>
<td>(P-1119-08)</td>
</tr>
<tr>
<td>K. Sangmanee</td>
<td>(P-2243-16)</td>
</tr>
<tr>
<td>Kabat Pavel</td>
<td>(P-2217-22)</td>
</tr>
<tr>
<td>Kaberi Helen</td>
<td>(P-3326-05)</td>
</tr>
<tr>
<td>Kabisa Mulako</td>
<td>(P-2225-07)</td>
</tr>
<tr>
<td>Kachroudi Nesrine</td>
<td>(P-1105-14)</td>
</tr>
<tr>
<td>Kacou, Modeste</td>
<td>(P-3330-34)</td>
</tr>
<tr>
<td>Kaempfer N.</td>
<td>(P-1105-03)</td>
</tr>
<tr>
<td>Kafando Petronille</td>
<td>(P-3330-40)</td>
</tr>
<tr>
<td>Käferhaus Jochen</td>
<td>(P-3305-09)</td>
</tr>
<tr>
<td>Kahime Kholoud</td>
<td>(P-3321-07)</td>
</tr>
<tr>
<td>Kaimuddin Awaluddin</td>
<td>(P2209-03)</td>
</tr>
<tr>
<td>Kainuma Mikiko</td>
<td>(K-4414-02, P-4414-12)</td>
</tr>
<tr>
<td>Kainur, S</td>
<td>(P-4415-06)</td>
</tr>
<tr>
<td>Kaisermann Aurore</td>
<td>(P-2213-02)</td>
</tr>
<tr>
<td>Kallbekken, Steffen</td>
<td>(P-4409-36)</td>
</tr>
<tr>
<td>Kam, Jonghun</td>
<td>(P-1119-08)</td>
</tr>
<tr>
<td>Kamae Youichi</td>
<td>(O-1118b-04)</td>
</tr>
<tr>
<td>Kamagate Bamory</td>
<td>(P-3330-17, P-3330-16, P-2212a-03,</td>
</tr>
<tr>
<td>Kamal Abu Hena Mustafa</td>
<td>(P-1111-11, P-2210-05)</td>
</tr>
<tr>
<td>Kamavisdar Anand</td>
<td>(P-1123-07)</td>
</tr>
<tr>
<td>Kamepalli Lenin Babu</td>
<td>(P-4406-05)</td>
</tr>
<tr>
<td>Kaminker Christopher</td>
<td>(K-4404-02)</td>
</tr>
<tr>
<td>Kammen Daniel</td>
<td>(P-3303-14, O-2237b-03, P-3303-08,</td>
</tr>
<tr>
<td>Kanae Shinjiro</td>
<td>(P-1123-04)</td>
</tr>
<tr>
<td>Kanas Tony</td>
<td>(O-1111b-03)</td>
</tr>
<tr>
<td>Kane, Evan</td>
<td>(P-1116-14)</td>
</tr>
<tr>
<td>Kang, Hyun–Suk</td>
<td>(P-2223-12)</td>
</tr>
<tr>
<td>Kanga Ide Soumila</td>
<td>(P-2222-06)</td>
</tr>
<tr>
<td>Kangogo Daniel</td>
<td>(O-3341-04)</td>
</tr>
<tr>
<td>Kanie, Norichika</td>
<td>(O-4401-01)</td>
</tr>
<tr>
<td>Kaniewski David</td>
<td>(O-1101-01)</td>
</tr>
<tr>
<td>Kanninen, Markku</td>
<td>(O-2219-03)</td>
</tr>
<tr>
<td>Kanudia Amit</td>
<td>(P-3322-07, O-3335-03)</td>
</tr>
<tr>
<td>Kapos Valerie</td>
<td>(P-2214-14, O-2219-04)</td>
</tr>
<tr>
<td>Karagatzides, Jim</td>
<td>(P-3320-04)</td>
</tr>
<tr>
<td>Karambiri Harouna</td>
<td>(P-3330-28, O-3330a-02, P-2212a-05)</td>
</tr>
<tr>
<td>Karathanassis Helen</td>
<td>(P-4407-01)</td>
</tr>
<tr>
<td>Karcher Michael</td>
<td>(O-1112-02)</td>
</tr>
<tr>
<td>Karesh William B</td>
<td>(O-2226-01)</td>
</tr>
<tr>
<td>Karfakis Panagiotis</td>
<td>(P-3328-01)</td>
</tr>
<tr>
<td>Karim Muhammad</td>
<td>(P-2224-13)</td>
</tr>
<tr>
<td>Karoly David</td>
<td>(O-1118a-01, O-1104-05, O-1113-01,</td>
</tr>
<tr>
<td>Karsenty Alain</td>
<td>(O-1118b-06)</td>
</tr>
<tr>
<td>Karpytchev Mikhail</td>
<td>(O-1111b-03, O-1111b-02)</td>
</tr>
<tr>
<td>Karri Saarnio</td>
<td>(P-1105-14)</td>
</tr>
<tr>
<td>Karrouk Mohammed–Said</td>
<td>(P-1106-02)</td>
</tr>
<tr>
<td>Karsenty Alain</td>
<td>(P-2216-03)</td>
</tr>
<tr>
<td>Kasangala Junior Mashango</td>
<td>(P-2217-14)</td>
</tr>
<tr>
<td>Kasecker, Thais</td>
<td>(P-2244-02)</td>
</tr>
</tbody>
</table>
Kasei Raymond (P-3328-07)
Kashino, Yuji (O-1110-01)
Kasper Kok (P-2236-08)
Kassam Karim–Aly Saleh (K-2234–01)
Kassin Koffi E. (P-3330–20)
Kato E. (K–L3.5–04)
Kattriona Mcglade (P-4409–17)
Kätterer, Thomas (P-1116–11)
Kattumuri Ruth (P-3302–05)
Kauker Frank (O-1112–02)
Kauneckis Derek (P-3311–11)
Kaur Navreet (P-3305–10)
Kaur Ravneet (P-2225–08, P-3305–10)
Kawan Rasmila (O-3318–04)
Kawazoe Fumie (K–1115–01)
Kay Alison (O-1118a–02)
Kayanne Hajime (P-2243–08)
Kazaglis Alex (P-3303–09)
Kazan, Victor (P-1115–12, P-1115–03)
Keckhut Philippe (P-1105–03, O-1108–03, P-1108–01, O-1108–02)
Keeble James (P-1108–02)
Kejun J. (K–L3.1–03)
Keller, David (P-3301–09)
Kellmann Sylvia (P-1108–02)
Kempen B (O-1105b–04)
Kemp Luke (P-4409–18)
Kendrovski, Vladimir (P-3337–03, O-1121–01)
Kendrovski Vladimir (P-1123–08)
Kennedy Erin (P-2240–10)
Kersting Jan (P-4418–17)
Kertesz A. (P-2204–05)
Kesavar Santosh (P-4415–06)
Kessler, William (O-1110–01)
Kestemont Marie–Paule (P-1121–04)
Kestemont Marie–Paule (P-1117–27)
Ketiem, Patrick (K–3312–01)
Keuschnig, Markus (O-2203–03)
Khabarov Nikolaï (P-2223–07)
Khadka Bidur (P-2214–11)
Khalil Mohammad I. (P-1115–04)
Khan Fouad Muhammad (O-2228–02)
Khan Sahibzada Irfanullah (P-3332–01)
Khan Zahirul (O-1111b–03)
Khan Zoheb Mahmud (P-3341–10)
Khaykin, Sergey (O-1108–03)
Khodri Myriam (O-1103–05, P-3330–13)
Khodri Myriam (P-1102–17)
Khokhlov Valeriy (P-1118–05)
Khoms Kenza (P-1113–07)
Khosla Radhika (P-3305–11)
Khvorostyanov Dmitry (O-1121–05)
Kienberger Stefan (O-2203–03)
Kifle Medhin (P-2224–14)
Kiguchi Masashi (P-2204–17)
Kikuchi Nobuhiro (K–1115–01)
Kilmian, Ralf (O-2231–01, O-2231–06, P-2231–01)
Kilibarda Milan (P-1117–24)
Kim, Jeong–Yun (P-2223–12)
Kim Heon–Sook (K–1115–01)
Kim Ho (P-1121–07, P-3321–08)
Kim Hyun Uk (P-4414–08)
Kim Hyungjun (P-2202–05)
Kim Jeoung–Yun (P-1121–01)
Kim Joeng–Geun (P-3307–06)
INDEX OF AUTHORS

Kimoto Masahide (O-1118b-04)  
Kinda Péléga (P-3330-43)  
King, Carey (P-2218-08)  
King, Scott (O-2245-05)  
King Andrew (O-1118a-01, O-1113-01)  
King D. (K-L1.4-01)  
Kinguyu, Stephen (P-4409-28)  
Kinney Patrick (O-3318-01, K-1121-01)  
Kinyangi James (P-2238-08, P-4409-28, P-2225-16)  
Kipkoech, Anderson (K-3312-01)  
Kirchengast Gottfried (P-1105-09, P-1105-18)  
Kirman Alan (O-3326-04)  
Kirscht, H. (P-2225-11)  
Kisekka–Ntale Fredrick (P-2216-05)  
Kissel, Catherine (O-1110-05)  
Kitous, Alban (O-4402a-02, O-3335-03, P-2204-14)  
Kitous, Alban (P-3303-22)  
Kittner Noah (P-3303-08)  
Kiyar, Dagmar (P-3305-16)  
Kiyoshi Takahashi (P-2204-17, P-2202-02, P-4419-01)  
Kjellstrom, Tord (P-2204-07)  
Klein, Geoffrey (P-1117-38)  
Klein Cornelia (P-1104-04)  
Klein David (P-2217-13)  
Klein Goldewijk, K (P-2217-25)  
Klein Julia (O-2211-01)  
Kleinschmitt Christoph (O-3301-01)  
Kleinwechter Ulrich (O-2218-01)  
Klemun Magdalena (P-1114-12)  
Klenert, David (K-3308-03)  
Klimont, Zig (O-1122-06, O-1121-02)  
Klimova Tatiana (P-3321-09)  
Klinger, Terrie (O-2207-04, P-2207-04, K-2243-02)  
Klinsky Sonja (O-4412-04)  
Kloos Julia (O-2220-01)  
Klumpp Katja (P-2218-05, P-1115-06)  
Klutse Nana Ama Browne (P-3330-60, P-1113-08)  
Knaus Maria (O-4406b-04)  
Knoblauch, Christian (P-1116-14)  
Knutti Reto (O-1102-02)  
Kober Tom (K-3335-02, O-3335-03, P-4402-07)  
Koch, Nicolas (O-4420b-02, P-3339-01)  
Köchy Martin (P-2223-01)  
Kodera Kunihiko (O-1108-02)  
Koech Eunice (P-1102-09)  
Koelbl, Barbara (O-3307-02)  
Koelle Bettina (P-2239-08)  
Koenig, Zoé (O-3327-02)  
Koenig Martin (O-3322b-02)  
Koffi Kouakou Valentin (P-3330-44)  
Köhnl Michael (P-2219-12)  
Koirala, Madan (P-1117-11, P-2214-02)  
Kojima Juliana Tomomi (P-2213-03)  
Kok Marcel (P-2214-12, P-3328-17)  
Koko L. K. A. (P-3330-20)  
Koks Elco (O-3322b-03)  
Kokwe, Misael (P-2219-04)  
Kollert Walter (K-L3.5-05)  
Kombat Lambini Cosmas (P-3331-02)  
Komorowski, Jean–Christophe (O-1103-03)  
Komutunga Everlyne (P-3312-15)  
Konaré A. (P-3330-20, P-3328-08)  
Konaré Abdourahaman (P-2212a-03, P-1117-47, P-1117-16, P-3328-19)  
Konareh Hamidou (O-3325b-03)  
Kone, Daouda (O-2244-02)
INDEX OF AUTHORS

International Scientific Conference     7-10 JULY 2015    PARIS, FRANCE

Krapp Mario (O-4406b-04)
Krasakopoulou Evangelia (P-2207-03)
Krause Andreas (O-2217-02, P-2217-16)
Kraxner Florian (P-3307-02)
Kreft Sönke (K-4407-01)
Kreibich Heidi (P-1119-09, P-3337-02)
Kreidenweiß Ulrich (P-2217-13)
Krey Volker (K-3302-01, O-4402a-01)
Krick, Benjamin (P-3305-07)
Kriegler Elmar (P-4402-02, O-3306-01, O-3307-01 (part1), O-3307-02, K-4402a-02, K-3302-01, K-2206-04)
Krinner Gerhard (P-1107-05)
Krishnakanth, B.m (P-3332-02)
Krishnapillai Shadananan Nair (P-2212a-09)
Krishnaswamy Jagdish (P-2222-02)
Kristjanson Patti (P-3341-02, P-4414-09, O-2236-02)
Kristjanson Patty (O-3320-03)
Kröbel Roland (P-3320-15)
Kromp–Kolb Helga (O-4417-04)
Kron Amanda (P-2242-04)
Krook–Riekkola Anna (P-3322-08)
Kropp, Juergen (P-2226-02)
Krowicki Florence (K-2212b-03)
Kruger, Andries (P-1113-14)
Kruger Elizabeth (P-4410-04)
Krüger Kirstin (O-1103-02, K-1103-02)
Krüger Tim (P-3307-03)
Krüger Wikus (P-3330-45)
Krujilt Bart (P-2236-08, O-2204-04, O-2244-01, P-2215-04)
Krummenauer, Linda (P-2226-02)
Krus Martin (O-2231-06)
Krysztofiak Gisele (P-1108-07)

Koné Armand (O-3325b-03)
Kongsager Rico (P-2225-09, P-2216-07, P-2217-15)
Kooiman Andre (P-2234-05)
Kooistra Lammert (O-2219-06)
Koththan Vanitha (P-2225-15)
Korgo Bruno (P-1105-07)
Kornek Ulrike (P-4401-01, P-4409-21, P-4409-19)
Kornhuber, Kai (O-1113-07)
Körösi, Csaba (K-4401-01)
Korosuo, Anu (O-4402b-01)
Kortschak Dominik (O-4408-06)
Kostick, Connor (O-1103-02)
Kotlarски, Sven (O-3303-01)
Koto N’gobi Gabin (P-3315-09)
Kotova Lola (P-2231-01, O-2231-10)
Koudio Kouakou (P-1117-16)
Koudio Yves (P-3330-09, P-1117-51, O-1106-01)
Kouakou Patrice (O-3330b-01, P-3330-58)
Kouamé, François N. (O-2244-02)
Kouamé B. (P-3330-20)
Kouame François N. (P-2244-01)
Kouami Kokou (P-2232-02)
Kouassi N. K. (P-3330-20)
Kouli Katerina (P-3326-05)
Kounouhewa Basile (P-3330-52)
 Koutroulis Aristeidis (O-2205-04, P-2204-14)
Kovaks, K. (O-4418b-01)
Kovats Sari (P-1121-11, O-3321-03)
Koven Charles (K-1116-02)
Kowarsch, Martin (P-4409-15)
Kpan Noel Vei (O-2244-03)
Krainer Karl (P-1101-04)
Kramer, Jonathan (O-4418a-02)

Krummenauer, Linda (P-2226-02)
## INDEX OF AUTHORS

<table>
<thead>
<tr>
<th>Author</th>
<th>Index Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kugler Noémie</td>
<td>P-2203-01, P-4409-26</td>
</tr>
<tr>
<td>Kuhlbrodt Till</td>
<td>O-2245-03</td>
</tr>
<tr>
<td>Kuhner Martina</td>
<td>P-4409-20</td>
</tr>
<tr>
<td>Kumar, Pavan</td>
<td>P-2205-07, P-1113-09</td>
</tr>
<tr>
<td>Kumar Jaywardhan</td>
<td>P-3342-04</td>
</tr>
<tr>
<td>Kumar Pawan</td>
<td>P-1117-17</td>
</tr>
<tr>
<td>Kumar Rajender</td>
<td>P-2222-04</td>
</tr>
<tr>
<td>Kumar Rajesh</td>
<td>P-1123-07</td>
</tr>
<tr>
<td>Kundzewicz Zbigniew</td>
<td>O-2212a-01</td>
</tr>
<tr>
<td>Kundzewicz Zbigniew W.</td>
<td>P-3337-01</td>
</tr>
<tr>
<td>Kunelius Risto</td>
<td>O-4419-01</td>
</tr>
<tr>
<td>Kunstmann Harald</td>
<td>P-1104-04</td>
</tr>
<tr>
<td>Kuria Kose</td>
<td>P-2236-02</td>
</tr>
<tr>
<td>Kurien Anish Mathieu</td>
<td>P-3328-06</td>
</tr>
<tr>
<td>Kuriger Janine</td>
<td>P-4418-27</td>
</tr>
<tr>
<td>Kurnaz Levent</td>
<td>P-1123-177</td>
</tr>
<tr>
<td>Kurniawan Eko Budi</td>
<td>O-4415a-02</td>
</tr>
<tr>
<td>Kurosawa Atsushi</td>
<td>P-4402-10</td>
</tr>
<tr>
<td>Kussul Natalia</td>
<td>P-1105-08</td>
</tr>
<tr>
<td>Kusuiarti, Siti</td>
<td>P-3341-11</td>
</tr>
<tr>
<td>Kutsch Werner L</td>
<td>O-1115-01, P-2235-01</td>
</tr>
<tr>
<td>Kuwar Thapa Udyaa</td>
<td>P-1117-19</td>
</tr>
<tr>
<td>Kvalevåg Maria Malene</td>
<td>K-3318-01</td>
</tr>
<tr>
<td>Kvilividze Khatuna</td>
<td>P-2222-03</td>
</tr>
<tr>
<td>Kvinikadze Lela</td>
<td>P-1115-13</td>
</tr>
<tr>
<td>Kwak Kyeong Yoon</td>
<td>P-2243-05</td>
</tr>
<tr>
<td>Kwon Ho-Young</td>
<td>P-2217-12</td>
</tr>
<tr>
<td>Kyoungmi Lee</td>
<td>P-2223-12</td>
</tr>
<tr>
<td>Kypreos Socrates</td>
<td>O-33322b-01</td>
</tr>
<tr>
<td>Kyte Rachel</td>
<td>K-2202-01</td>
</tr>
<tr>
<td>L. Pan</td>
<td>P-2214-19</td>
</tr>
<tr>
<td>L’helguen Stéphane</td>
<td>P-1111-04</td>
</tr>
<tr>
<td>L’hévédé Blandine</td>
<td>P-1110-03</td>
</tr>
<tr>
<td>L’hôte, David</td>
<td>O-1104-04</td>
</tr>
<tr>
<td>La Greca Simone</td>
<td>P-4402-07</td>
</tr>
<tr>
<td>La Jeunesse Isabelle</td>
<td>P-3326-07</td>
</tr>
<tr>
<td>La Rovere Emilio</td>
<td>K-L3.1-05, O-4414-06</td>
</tr>
<tr>
<td>Laanaia Nabil</td>
<td>K-2218-03, P-1102-03</td>
</tr>
<tr>
<td>Labandeira Xavier</td>
<td>O-3333-01</td>
</tr>
<tr>
<td>Labat, Ariane</td>
<td>O-4402a-02, P-3303-22</td>
</tr>
<tr>
<td>Labat David</td>
<td>O-3325b-02</td>
</tr>
<tr>
<td>Labib Mounir Wahba</td>
<td>O-3304-01</td>
</tr>
<tr>
<td>Labordena Mercè</td>
<td>P-3303-10</td>
</tr>
<tr>
<td>Labriet Maryse</td>
<td>P-3322-07, O-3335-03</td>
</tr>
<tr>
<td>Lac, Christine</td>
<td>P-1115-15</td>
</tr>
<tr>
<td>Lacarra, Maité</td>
<td>O-3327-02</td>
</tr>
<tr>
<td>Lacressonnière Gwendoline</td>
<td>O-2205-03</td>
</tr>
<tr>
<td>Lacroix Gérard</td>
<td>O-2213-01</td>
</tr>
<tr>
<td>Laderach Peter</td>
<td>P-2223-05, P-2225-11, P-2225-12</td>
</tr>
<tr>
<td>Ladouche, B.</td>
<td>P-2212b-04</td>
</tr>
<tr>
<td>Ladstädter Florian</td>
<td>P-1105-09, P-1105-18</td>
</tr>
<tr>
<td>Laë Raymond</td>
<td>P2209-03</td>
</tr>
<tr>
<td>Lafayse Matthieu</td>
<td>O-2211-04</td>
</tr>
<tr>
<td>Lafont Sebastien</td>
<td>P-2216-08, P-1115-06, P-1115-07</td>
</tr>
<tr>
<td>Lagadeuc Yvan</td>
<td>P-2239-05</td>
</tr>
<tr>
<td>Lagaria Anna</td>
<td>P-2207-03</td>
</tr>
<tr>
<td>Lagarrigue, Andrés</td>
<td>P-3335-02</td>
</tr>
<tr>
<td>Lago, Manuel</td>
<td>K-3309-01</td>
</tr>
<tr>
<td>Lagroix France</td>
<td>P-1102-07</td>
</tr>
<tr>
<td>Lahiri Chakravarty Smwarajit</td>
<td>O-3332-01</td>
</tr>
<tr>
<td>Lahsen, Myanna</td>
<td>P-3320-18, P-2240-09</td>
</tr>
<tr>
<td>Laignel Benoit</td>
<td>P-2212a-14</td>
</tr>
<tr>
<td>Lakatos Mónika</td>
<td>P-1113-10</td>
</tr>
<tr>
<td>Lalljee Bhanoooduth</td>
<td>P-2224-15</td>
</tr>
</tbody>
</table>
Laude-Depezay Audrey (P-3307-05)
Laureau, Axel (P-3303-03)
Laurent, Olivier (P-1115-12, P-1105-14)
Laurent Husson (P-1107-04)
Laurila Tuomas (P-1105-14)
Lavaysse Christophe (P-3330-46)
Lavigne Franck (P-4418-19, O-1103-03)
Lavorel Sandra (K-2214-02, K-2220-01, K-2213-01, O-2211-01)
Lavreniuk Mykola (P-1105-08)
Law Beverly (O-2245-04)
Lawhead Jonathan (O-3301-04)
Lawin Agnidé Emmanuel (P-3330-47)
Lawrence, David M. (K-1116-02)
Lawrence Peter (O-2217-03)
Lazare Kouassi Kouakou (P-1102-12)
Lazzari, Paolo (P2209-09)
Le Borgne Ewen (O-4414-02)
Le Bris Nadine (P-2208-02, P-2208-03)
Le Cozannet Goneri (P-2210-03, P-2210-04, P-4418-19, P-2239-01, P-1107-13, P-4418-09)
Le Duff Matthieu (P-3342-02)
Le Hir Pierre (P-2210-06)
Le Lay Matthieu (K-2212b-03)
Le Masson Virginie (O-3341-06)
Le Mouël Chantal (P-2223-08)
Le Pichon Alexis (P-1108-01)
Le Quéré Corinne (K-1116-01)
Le Roux Xavier (P-2224-07, P-1116-13)
Le Toan Thuy (P-2219-09, P-1105-09)
Le Treut Gaëlle (P-4420-01)
Leadley Paul (P-1116-13, O-2214-02)
Leahey, Erin (P-4418-12)
Learnmore Mwadzingeni (P-3320-21)
INDEX OF AUTHORS

Leauthaud Crystele (P-3330-36, P-3330-48)
Lee Young-Joo (P-3307-06)
Lebdi Fethi (P-1119-10)
Lefale Penehuho Fatu (P-1105-10)
Lebel Louis (P-3342-01, P-2240-11)
Lefevre Carmen (O-2240-02)
Lebel Phimphakan (P-2240-11)
Lefevre François (O-2244-06)
Lebel Thierry (P-3330-65, K-3330a-01, P-3330-30)
Lefèvre François (P-3326-10)
Leblanc Karine (P-1111-04)
Lefèvre Jérôme (O-L1.5-01, O-1111a-02, P-1111-14)
Leblanc Marc (P-2212a-10)
Lefèvre Julien (P-3322-01)
Leblond Nathalie (P-1111-04, O-1110-05)
Lefèvre Laurent (P-3305-12)
Lefèvre Roger-Alexandre (O-2231-02)
Lefèvre Romain (P-1116-11)
Lefort Stelly (P2209-04)
Le Gall Cécile (P-2225-06)
Leber C. (K-1105a-03, P-1107-01, P-1107-09)
Legave Jean-Michel (P-3326-03)
Legendre Stéphane (O-2213-01)
Legeais J.-F. (K-1105a-03, P-1107-01, P-1107-09)
Legg Tim (O-1118a-02)
Legrand Michel (P-1107-05)
Legoet Benoît (O-4404-02)
Lehen F. (K-L1.1-02)
Lehmann, Jascha (P-1113-07)
Lehner F. (K-L1.1-02)
Lehodey Patrick (O-2209-01, P2209-01)
Lehr Ulrike (K-3309-03)
Lehtila A. (O-33322b-01)
Leiho Kevilaiu Gustaf (O-2231-10)
Leercah F. (K-4414-03, O-3305-01, O-3305-06)
Leclerc Christian (K-2224-04)
Leclerc Liza (P-3311-08)
Legreve Jean-Michel (P-3326-03)
Lecomte, Pascal (K-1105a-01)
Legereis J.-F. (K-1105a-03, P-1107-01, P-1107-09)
Lecuyer, Oskar (O-3339-02)
Legendre Stéphane (O-2213-01)
Lede Barbora (P-1117-39)
Legg Tim (O-1118a-02)
Leduc, Guillaume (K-1103-01)
Legrand Michel (P-1107-05)
Leduc, Sylvain (P-3307-02)
Legoet Benoît (O-4404-02)
Lee Jejin (O-1116-03)
Lehmann, Jascha (P-1113-07)
Lee Allison (P-1105-12)
Lehner F. (K-L1.1-02)
Lee Caroline (P-3306-03)
Lehodey Patrick (O-2209-01, P2209-01)
Lee Craig (K-1112-01)
Lehr Ulrike (K-3309-03)
Leenalars J.g.b. (O-1105b-04)
Lehtila A. (O-33322b-01)
Lee Ho Ching (O-4407-03, P-1123-172)
Leitner Markus (O-2233-04)
Lee Ju Hyoung (P-1117-20, P-2212a-23)
Leitner Markus (O-2233-04)
Lee Moonhwan (P-2212a-02)
Lejart Morgane (P-3302-01)
Leenaars J.g.b. (O-1105b-04)
Leloup, Julie (P-1119-18)
Leenhardt Pierre (P-2236-11)
Lemarié Stéphane (P-2224-07)
Lee Seung-Wook (P-1121-01)
Le Meur Emmanuel (P-1107-05)
Lee Shih-Yu (P-2245-04)
Lemeur Pierre-Yves (P-1111-07)
Lee Soo-Jae (P-2243-05)
Lemke, Bruno (P-2204-07)
Lejonhufvud Gustaf (O-2231-10)
<table>
<thead>
<tr>
<th>Author Name</th>
<th>Code Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lemoalle Jacques</td>
<td>(P-2222-05)</td>
</tr>
<tr>
<td>Lemonsu Aude</td>
<td>(P-4415-07)</td>
</tr>
<tr>
<td>Lemos, Maria Carmen</td>
<td>(P-3312-13)</td>
</tr>
<tr>
<td>Lempert Robert</td>
<td>(K-2236-02)</td>
</tr>
<tr>
<td>Lengaigne Matthieu</td>
<td>(O-1119b-01, P-1111-01, O-1111a-01, O-2209-01, O-1111a-02, K-1111a-02, P2209-01, K-L1.5-02, O-L1.5-01)</td>
</tr>
<tr>
<td>Lennard Christopher</td>
<td>(P-1113-11, O-2201-01, O-1104-01)</td>
</tr>
<tr>
<td>Lenoble Arnaud</td>
<td>(O-2210-03)</td>
</tr>
<tr>
<td>Len Shaffrey</td>
<td>(P-1118-03, O-1118b-01, O-2201-02)</td>
</tr>
<tr>
<td>Lenton Andrew</td>
<td>(P-3301-09)</td>
</tr>
<tr>
<td>Lenton Tim</td>
<td>(K-L2.4-01, P-2203-04)</td>
</tr>
<tr>
<td>Leon, Amanda</td>
<td>(O-1105b-05)</td>
</tr>
<tr>
<td>Léone Frédéric</td>
<td>(P-2236-10)</td>
</tr>
<tr>
<td>Leopold, Audrey</td>
<td>(O-1111b-04)</td>
</tr>
<tr>
<td>Lereboullet Anne-Laure</td>
<td>(P-2224-16)</td>
</tr>
<tr>
<td>Leroux Louise</td>
<td>(P-3330-65)</td>
</tr>
<tr>
<td>Leroux Stéphanie</td>
<td>(O-1117-03)</td>
</tr>
<tr>
<td>Leroy Suzanne a.g.</td>
<td>(O-2241-05)</td>
</tr>
<tr>
<td>Leroy Sylvestre</td>
<td>(P-4418-09)</td>
</tr>
<tr>
<td>Lesales Thierry</td>
<td>(P-2236-10)</td>
</tr>
<tr>
<td>Lescuyer Guillaume</td>
<td>(P-3331-01)</td>
</tr>
<tr>
<td>Leseur, Alexia</td>
<td>(P-4415-02)</td>
</tr>
<tr>
<td>Lesse Paolo</td>
<td>(P-2224-17)</td>
</tr>
<tr>
<td>Lessmann Kai</td>
<td>(P-4401-01, P-4409-15, P-4409-21, P-4409-19, K-4405-01)</td>
</tr>
<tr>
<td>Lester King</td>
<td>(O-2229-04)</td>
</tr>
<tr>
<td>Lester Kwieatkowski</td>
<td>(P-3301-05)</td>
</tr>
<tr>
<td>Leuxe André</td>
<td>(O-2230-01)</td>
</tr>
<tr>
<td>Levermann Anders</td>
<td>(P-1107-10, P-2204-16, P-2210-01, O-2237a-03)</td>
</tr>
<tr>
<td>Levi Jacob</td>
<td>(P-2212a-16)</td>
</tr>
<tr>
<td>Levin, Ingeborg</td>
<td>(O-1115-01)</td>
</tr>
<tr>
<td>Levina, Ellina</td>
<td>(P-3306-03)</td>
</tr>
<tr>
<td>Levin Lisa</td>
<td>(K-2208-01)</td>
</tr>
<tr>
<td>Levis, Sam</td>
<td>(P-2217-26)</td>
</tr>
<tr>
<td>Levy, Marc</td>
<td>(O-1105b-01)</td>
</tr>
<tr>
<td>Levy, Oren</td>
<td>(O-2207-02)</td>
</tr>
<tr>
<td>Lewin Keith</td>
<td>(P-2215-04)</td>
</tr>
<tr>
<td>Lewis, Sophie</td>
<td>(O-1118a-01, O-1113-01)</td>
</tr>
<tr>
<td>Lexen Karin</td>
<td>(O-2212b-04)</td>
</tr>
<tr>
<td>Leyequien Abarca Euridice</td>
<td>(O-2244-01)</td>
</tr>
<tr>
<td>Leyequien Euridice</td>
<td>(P-2214-13)</td>
</tr>
<tr>
<td>Lézine Anne-Marie</td>
<td>(K-1101-01)</td>
</tr>
<tr>
<td>Lherminier Pascale</td>
<td>(O-1110-04)</td>
</tr>
<tr>
<td>Li, Chao</td>
<td>(O-1102-02, O-1122-02)</td>
</tr>
<tr>
<td>Li, Guangqi</td>
<td>(O-1102-05)</td>
</tr>
<tr>
<td>Liao Pei-Shan</td>
<td>(P-3321-11)</td>
</tr>
<tr>
<td>Libourel Thérèse</td>
<td>(P-4418-03, P-4418-22)</td>
</tr>
<tr>
<td>Lidija Srnec</td>
<td>(P-1113-12)</td>
</tr>
<tr>
<td>Lidskog Rolf</td>
<td>(O-2239-01)</td>
</tr>
<tr>
<td>Liebscher Axel</td>
<td>(O-3307-03)</td>
</tr>
<tr>
<td>Liedtke Christa</td>
<td>(O-3317-05)</td>
</tr>
<tr>
<td>Lieffering Mark</td>
<td>(K-2223-02)</td>
</tr>
<tr>
<td>Liesbet Van De Casteele</td>
<td>(O-3337-01)</td>
</tr>
<tr>
<td>Libusk Alve</td>
<td>(O-1111b-02)</td>
</tr>
<tr>
<td>Li Jun</td>
<td>(P-3303-12, O-4414-01, P-3330-49)</td>
</tr>
<tr>
<td>Likhvar Victoria</td>
<td>(O-1121-03)</td>
</tr>
<tr>
<td>Li L</td>
<td>(P-2201-03)</td>
</tr>
<tr>
<td>Lilia Biktash</td>
<td>(P-1117-21, P-1117-22)</td>
</tr>
<tr>
<td>Lillebø Ana</td>
<td>(P-4409-22, P-2239-01)</td>
</tr>
<tr>
<td>Lilliestam, Johan</td>
<td>(P-3303-18, P-3303-10)</td>
</tr>
<tr>
<td>Lima M.I.</td>
<td>(P-4409-22)</td>
</tr>
<tr>
<td>Li Man</td>
<td>(P-2217-12, P-2219-08)</td>
</tr>
<tr>
<td>Limmeechokchai Bundit</td>
<td>(P-4414-10, O-3311-02)</td>
</tr>
<tr>
<td>Limpiada Angela</td>
<td>(O-2233-05)</td>
</tr>
<tr>
<td>Lin, Xiaopei</td>
<td>(O-1110-01)</td>
</tr>
</tbody>
</table>
# INDEX OF AUTHORS

<table>
<thead>
<tr>
<th>Author Name</th>
<th>Reference Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lin Chuan-Yao</td>
<td>(P-3321-11)</td>
</tr>
<tr>
<td>Lindenmann Alexandra Schleyer</td>
<td>(O-3326-01)</td>
</tr>
<tr>
<td>Lindenthal Thomas</td>
<td>(O-4417-04)</td>
</tr>
<tr>
<td>Lindeskov, Mats</td>
<td>(P-2217-25, P-2217-16)</td>
</tr>
<tr>
<td>Lindquist, Erik</td>
<td>(P-2219-05)</td>
</tr>
<tr>
<td>Lin Elaine Kuan–Hui</td>
<td>(P-2233-02)</td>
</tr>
<tr>
<td>Linsbauer Andreas</td>
<td>(P-1117-23, P-4418-27)</td>
</tr>
<tr>
<td>Lins Harry</td>
<td>(K-2212a-02)</td>
</tr>
<tr>
<td>Liouss Cathy</td>
<td>(O-3318-02)</td>
</tr>
<tr>
<td>Lipper, Leslie</td>
<td>(P-3328-01, P-2219-04, P-2240-06)</td>
</tr>
<tr>
<td>Lippold, Joerg</td>
<td>(O-1102-09)</td>
</tr>
<tr>
<td>Lisboa, Leila</td>
<td>(P-2215-05, P-2214-15)</td>
</tr>
<tr>
<td>Li Shuo</td>
<td>(K-3333-03)</td>
</tr>
<tr>
<td>Lissner Tabea</td>
<td>(P-2236-12, P-2203-03)</td>
</tr>
<tr>
<td>Li Tiantian</td>
<td>(K-3318-02)</td>
</tr>
<tr>
<td>Litre, Gabriela</td>
<td>(P-2240-16)</td>
</tr>
<tr>
<td>Liu Changxin</td>
<td>(P-33322b-05)</td>
</tr>
<tr>
<td>Liu Chun Lei</td>
<td>(P-1106-03)</td>
</tr>
<tr>
<td>Liu Li</td>
<td>(P-1121-05)</td>
</tr>
<tr>
<td>Liu Xiao</td>
<td>(P-4412-04)</td>
</tr>
<tr>
<td>Liu Yan</td>
<td>(P-1114-13)</td>
</tr>
<tr>
<td>Liu Yang</td>
<td>(P-3302-06)</td>
</tr>
<tr>
<td>Liu Yuanbo</td>
<td>(P-2212a-11)</td>
</tr>
<tr>
<td>Liu Zhengyu</td>
<td>(O-1102-07)</td>
</tr>
<tr>
<td>Livet, Frederic</td>
<td>(P-3302-02)</td>
</tr>
<tr>
<td>Livina Valerie</td>
<td>(P-1105-11)</td>
</tr>
<tr>
<td>Liwayway Adkins</td>
<td>(P-3306-03)</td>
</tr>
<tr>
<td>Li Wei</td>
<td>(O-2217-02)</td>
</tr>
<tr>
<td>Lizarazo Miguel</td>
<td>(P-2225-01)</td>
</tr>
<tr>
<td>Lizaso Jon</td>
<td>(O-2223-02)</td>
</tr>
<tr>
<td>Lloret Emily</td>
<td>(P-1119-04)</td>
</tr>
<tr>
<td>Lloyd, Simon</td>
<td>(P-3321-03)</td>
</tr>
<tr>
<td>Lo, Yun Jia</td>
<td>(P-3312-13)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Author Name</th>
<th>Reference Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lobell David</td>
<td>(K-22.5-05, P-2204-12, K-3330b-01)</td>
</tr>
<tr>
<td>Loboguerrero, Ana Maria</td>
<td>(O-2225-01)</td>
</tr>
<tr>
<td>Locatelli Bruno</td>
<td>(P-2217-15)</td>
</tr>
<tr>
<td>Lochte Karin</td>
<td>(K-3327-01)</td>
</tr>
<tr>
<td>Locoge, Nadine</td>
<td>(P-1114-08)</td>
</tr>
<tr>
<td>Loeb Norman</td>
<td>(P-1106-03)</td>
</tr>
<tr>
<td>Loeschel Andreas</td>
<td>(O-3333-01)</td>
</tr>
<tr>
<td>Lofts Katherine</td>
<td>(P-2242-04)</td>
</tr>
<tr>
<td>Lohre Steffen</td>
<td>(P-2229-07)</td>
</tr>
<tr>
<td>Loireau Maud</td>
<td>(P-4418-03)</td>
</tr>
<tr>
<td>Longdoz, Bernard</td>
<td>(P-1115-06)</td>
</tr>
<tr>
<td>Long Nathalie</td>
<td>(P-4415-07)</td>
</tr>
<tr>
<td>Long Thomas</td>
<td>(P-2225-02)</td>
</tr>
<tr>
<td>Longuevergne Laurent</td>
<td>(P-2212b-08, P-1107-11)</td>
</tr>
<tr>
<td>Lookzadeh Sedighe</td>
<td>(P-2245-02)</td>
</tr>
<tr>
<td>Loorbach Derk</td>
<td>(P-4409-13, O-4415b-02)</td>
</tr>
<tr>
<td>Lopes Gabriel</td>
<td>(P-3325-04)</td>
</tr>
<tr>
<td>Lopes Jucivan Ribeiro</td>
<td>(P-1117-31)</td>
</tr>
<tr>
<td>Lopes Lucas G.</td>
<td>(P-2212a-18)</td>
</tr>
<tr>
<td>López–Moreno, J.i.</td>
<td>(P-1119-19)</td>
</tr>
<tr>
<td>Lopez, Morgan</td>
<td>(P-1115-15, P-1115-12)</td>
</tr>
<tr>
<td>Lopez Luis</td>
<td>(P-4409-05)</td>
</tr>
<tr>
<td>López Noriega Isabel</td>
<td>(P-3311-04)</td>
</tr>
<tr>
<td>Lopez Paulina</td>
<td>(P-1107-11, P-1107-12)</td>
</tr>
<tr>
<td>Lorant Elisabeth</td>
<td>(P-2239-05)</td>
</tr>
<tr>
<td>Lorencová Eliska</td>
<td>(O-2220-01)</td>
</tr>
<tr>
<td>Lorenzo Josique</td>
<td>(P-2239-09)</td>
</tr>
<tr>
<td>Lossow, Stefan</td>
<td>(O-1108-05)</td>
</tr>
<tr>
<td>Lott, François</td>
<td>(P-1108-03)</td>
</tr>
<tr>
<td>Lotze–Campen Hermann</td>
<td>(P-2217-13, P-2219-13)</td>
</tr>
<tr>
<td>Loubet, Benjamin</td>
<td>(P-1115-06)</td>
</tr>
<tr>
<td>Loustau Denis</td>
<td>(K-2218-03, P-2216-08, P-1115-06, P-1115-07)</td>
</tr>
</tbody>
</table>
INDEX OF AUTHORS

Loutfi Kenza (P-2225-02)
Lovato, Tomas (P2209-09)
Low Choy Darryl (P-2236-16)
Lowe Jason (P-2218-09, P-4418-13)
Lowe Rachel (P-3321-10)
Loyzaga, M A Y (P-2217-30)
Lozouet Pierre (P-2208-01)
Lu, Chaoqun (P-1114-11)
Lucas M (P-2201-03)
Lucio Filipe (P-1104-06)
Lückenkötter, Johannes (P-4418-16, P-2236-13)
Lucquaud, Mathieu (O-3307-01 (part2))
Luderer Gunnar (P-4402-02, K-4402a-02)
Ludlow, Francis (O-1103-02)
Ludovic Oudin (O-3330a-02)
Ludwig Fulco (P-2217-22, P-2205-09)
Ludwig Ralf (P-3326-07)
Lugen Marine (P-4418-20)
Luís Álvaro (O-3312-02)
Luís Silva (P-4409-22, P-2239-01)
Luiz Augusto Costa (O-3304-03)
Luiz Felipe Mendes De Gusmao (O-2243-04)
Luke, Quentin (P-2219-10)
Lukovic Jelena (P-1117-24)
Lukovi Seke (P-4418-21)
Lundy, M. (P-2225-11)
Lungarska Anna (P-2217-17, K-2218-03)
Lung Shih-Chun (P-3321-11)
Luque Sandra (O-2216-02)
Luterbacher Juerg (O-1113-06, P-1113-23, P-3326-05, K-3326-02, O-2241-05)
Lutter Reimo (P-2216-11)
Lüttringhaus Anna-Sophia (O-4406b-04)

Luyssaert Sebastiaan (O-2219-02)
Lykousis Vasilios (P-3326-05)
Ly Mouhamed (P-1117-25)
Lyon Bradfield (O-1113-04)

M

M. Laouali Amadou (P-3330-50)
M. C. B. C. Diatta (O-2244-04)
M. Palm (P-3320-22)
M. Sutthacheep (P-2243-16)
Maamaatuaiahutapu Keitapu (P-1111-13)
Mabhaudhi Tafadzwanashe (P-3320-16)
Macarthur, Alianne (O-3313-03)
Mace Georgina (K-2214-03)
Machalaba Catherine (O-2226-01)
Machault Vanessa (O-2226-03, O-3321-07)
Mach Katharine (O-2203-01, P-2204-04)
Mackintosh Andrew (P-1101-05)
Maclachlan Craig (P-1117-33)
Macleod, Dave (P-3330-57)
Madalengoitia, Oscar (P-2239-03)
Madelangoria, Edith (K-3328-02)
Madelin Malika (P-2240-12)
Madina Doumbia (P-3318-04)
Madrigal, Róger (P-3312-03)
Maeke Joseph (P-2224-10, P-3320-14)
Maes Christophe (P-1111-13, O-1110-05)
Mafongoya Paramu L. (P-3328-09)
Magalhães E Silva Francisco Hilder (P-2215-06)
Magand Olivier (P-1107-05)
Magny M (K-1101-03)
Mahamane Larwanou (P-2218-04)
Mah Daphne (P-3303-13)
Mahé, Emmanuel (P-2226-04, P-2226-03)
<table>
<thead>
<tr>
<th>Author</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mahe Gil</td>
<td>O-1119b-05, O-1119a-01</td>
</tr>
<tr>
<td>Mahmoudi Mojgasadat</td>
<td>P-2213-04</td>
</tr>
<tr>
<td>Mahmoud Mahmoud Ibrahim</td>
<td>P-2217-18</td>
</tr>
<tr>
<td>Mahowald, Natalie M.</td>
<td>P-1116-12</td>
</tr>
<tr>
<td>Maidens Anna</td>
<td>P-1117-33</td>
</tr>
<tr>
<td>Maignon Fabienne</td>
<td>O-2219-02, P-2219-11</td>
</tr>
<tr>
<td>Mair V.</td>
<td>P-1101-04</td>
</tr>
<tr>
<td>Maizi Nadia</td>
<td>P-3303-14, O-3303-02, P-3303-04, P-3303-15</td>
</tr>
<tr>
<td>Majaliwa M.</td>
<td>K-L3.5-04</td>
</tr>
<tr>
<td>Makhaza Romeo</td>
<td>O-4406b-04</td>
</tr>
<tr>
<td>Makhubela Lulama</td>
<td>P-3328-06</td>
</tr>
<tr>
<td>Makoudjou, Adeline</td>
<td>P-2214-14, P-2215-07</td>
</tr>
<tr>
<td>Maksyutov Shamil</td>
<td>K-1115-01</td>
</tr>
<tr>
<td>Malagnoux Michel</td>
<td>K-3311-02</td>
</tr>
<tr>
<td>Malakoutikhah Shima</td>
<td>P-2214-05</td>
</tr>
<tr>
<td>Malam Abdou Moussa</td>
<td>P-3330-65, P-3330-19</td>
</tr>
<tr>
<td>Malek, Ziga</td>
<td>O-2203-03</td>
</tr>
<tr>
<td>Malekizadeh Ali Akbar</td>
<td>P-2217-20</td>
</tr>
<tr>
<td>Malerbe Florence</td>
<td>K-2212b-03</td>
</tr>
<tr>
<td>Malet Jean-Philippe</td>
<td>P-2211-01</td>
</tr>
<tr>
<td>Maljean-Dubois Sandrine</td>
<td>O-4403-03</td>
</tr>
<tr>
<td>Mallamburn Peter</td>
<td>O-3311-03</td>
</tr>
<tr>
<td>Mallea Javier</td>
<td>P-2236-07</td>
</tr>
<tr>
<td>Malleshappa H</td>
<td>P-1104-02</td>
</tr>
<tr>
<td>Mallet Marc</td>
<td>O-3318-02, O-1117-04</td>
</tr>
<tr>
<td>Mallick, Bishawjit</td>
<td>O-2233-02</td>
</tr>
<tr>
<td>Malpede Michele Maurizio</td>
<td>P-1115-08</td>
</tr>
<tr>
<td>Mamadou Daboua Mahamadou</td>
<td>P-3330-01</td>
</tr>
<tr>
<td>Mamadou Ossenatou</td>
<td>P-3330-52, P-3330-52</td>
</tr>
<tr>
<td>Manalaysay Danielle</td>
<td>P2209-07</td>
</tr>
<tr>
<td>Manca M</td>
<td>K-1101-03</td>
</tr>
<tr>
<td>Manceron Stéphane</td>
<td>P-2223-08</td>
</tr>
<tr>
<td>Mandal Shailendra</td>
<td>P-2229-04</td>
</tr>
<tr>
<td>Mander Sarah</td>
<td>K-3315-03</td>
</tr>
<tr>
<td>Manderscheid Remy</td>
<td>P-2223-02</td>
</tr>
<tr>
<td>Mandimbiniaina Rina</td>
<td>P-2219-07</td>
</tr>
<tr>
<td>Mandl, Sylvia</td>
<td>P-3316-01</td>
</tr>
<tr>
<td>Manei Carolyne</td>
<td>O-2238-02</td>
</tr>
<tr>
<td>Mangeas Mogan</td>
<td>P-4418-22, O-1111a-01, P-1111-07</td>
</tr>
<tr>
<td>Manglicmot Michelle</td>
<td>P2209-05</td>
</tr>
<tr>
<td>Mango Joash</td>
<td>O-3320-03</td>
</tr>
<tr>
<td>Mani Essomba Pauline Manuella</td>
<td>P-2212a-12</td>
</tr>
<tr>
<td>Mann, Michael</td>
<td>O-1110-03</td>
</tr>
<tr>
<td>Mant Rebecca</td>
<td>P-2214-14, O-2219-04, P-2215-07</td>
</tr>
<tr>
<td>Mantua Nathan</td>
<td>O-1117-01</td>
</tr>
<tr>
<td>Manyilizu Majuto</td>
<td>(P-1111-12)</td>
</tr>
<tr>
<td>Manzini Elisa</td>
<td>O-1108-02</td>
</tr>
<tr>
<td>Maqueo Octavio</td>
<td>P-2214-06</td>
</tr>
<tr>
<td>Marangoni, Giacomo</td>
<td>O-2237a-02</td>
</tr>
<tr>
<td>Marchadier Colette</td>
<td>P-4415-07</td>
</tr>
<tr>
<td>Marchal Virginie</td>
<td>P-4404-01</td>
</tr>
<tr>
<td>Marchand Cyril</td>
<td>O-1111b-04</td>
</tr>
<tr>
<td>Marchane Ahmed</td>
<td>P-2211-04</td>
</tr>
<tr>
<td>Marchant Rob</td>
<td>O-3329-01</td>
</tr>
<tr>
<td>Marchesiello Patrick</td>
<td>O-L1.5-01, O-1111a-02</td>
</tr>
<tr>
<td>Marchetto A</td>
<td>K-1101-03</td>
</tr>
<tr>
<td>Marc Metian</td>
<td>P-2207-02</td>
</tr>
<tr>
<td>Marcomini Antonio</td>
<td>P-2204-13</td>
</tr>
<tr>
<td>Marcos Juan E.</td>
<td>P-4414-11</td>
</tr>
<tr>
<td>Marcovechio, Jorge</td>
<td>P-1110-02</td>
</tr>
<tr>
<td>Marengo J.</td>
<td>K-L2.3-01</td>
</tr>
<tr>
<td>Marécal Virginie</td>
<td>O-2205-03</td>
</tr>
<tr>
<td>Maréchal Jean-Christophe</td>
<td>P-2212b-04</td>
</tr>
<tr>
<td>Maria N.</td>
<td>K-L1.4-03</td>
</tr>
<tr>
<td>Mariam Otmani Delbarrio</td>
<td>O-3321-01</td>
</tr>
</tbody>
</table>
INDEX OF AUTHORS

International Scientific Conference     7-10 JULY 2015    PARIS, FRANCE

Martinez Enrique (P-3326-08)
Martinez Felipe (P-2212b-09)
Martinez Jean Michel (K-1119a-02, P-1119-16)
Martini Frédérique (O-2212b-02)
Martini Severine (P2209-06)
Martin Marc-Antoine (O-2212b-03)
Martin Nicolas (P-3326-10)
Martin Ralf (O-4420a-01)
Martins-Costa Marilia (P-2245-07)
Martins Eduardo Sávio Passos Rodrigues (P-2215-06)
Martins Gabriel Souza (O-1119b-02)
Martiny, Nadège (P-2215-10)
Martius Christopher (K-2218-01)
Martorano, Lucieta (P-2214-16)
Martorano Lucia (O-2244-01, P-2215-05, P-2214-15)
Martrat Belen (O-1103-01, K-1103-01, P-3326-05, O-2241-05)
Marty, Christoph (P-1117-38)
Mary, Bruno (P-1115-06)
Maryam Soleimanitaba (P-2223-11)
Marzeion, Ben (P-2210-01)
Masaki Yoshimitsu (P-2204-17, P-2205-11)
Masanja Aloyce (P-2217-19)
Masante Dario (O-2244-01)
Maselli Daniel (P-4414-20)
Masoodian Masood (P-3321-02)
Massetti Emanuele (P-2236-14, P-2242-05, P-2223-13)

Mariangela Zoli (O-3339-03)
Mari Martiskainen (P-4413-05)
Marin, Vh (P-3322-09)
Mario Hernandez (K-1105b-02)
Mario Herrero (O-3320-03)
Mariola Acosta Frances (P-3341-06)
Markandyia A (K-2237a-03)
Marko Komac (P-1105-12)
Markus Bill (O-1116-15)
Markus Gehring (O-3323-03)
Marloie Olivier (O-1115-06)
Maron, Pierre-Alain (P-1116-11)
Marotzke, Jochem (O-1122-02)
Marques Ana (O-4415b-03)
Marquez Florentino (P-2230-02)
Marriner Nick (P-3326-13)
Marshall Julia (O-1115-02)
Marsland Simon (P-1106-04)
Martazinova Vf. (O-1117-49)
Martel Simon (P-2216-08)
Marti, Olivier (P-1119-18)
Marticorena Beatrice (P-3330-53, P-3330-01)
Martín-Hernández, N. (P-1119-19)
Martin, Corinne (P2209-09)
Martin, Elinor (P-3330-77)
Martin, T. (O-4418b-01)
Martin Brice (O-1101-04)
Martinelli, Luiz Antonio (P-2215-09)
Martin Eric (P-2212b-08, O-1119b-04, P-2205-02, O-2211-04)
Martinez–Hernández Enrique (P-1101-01)
Martinez–Ponce, Josefina (P-1121-08)
Martinez Elodie (P-1111-13)
## INDEX OF AUTHORS

<table>
<thead>
<tr>
<th>Author Name</th>
<th>Index Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Massey Eric</td>
<td>K-2217-01</td>
</tr>
<tr>
<td>Massey Neil</td>
<td>O-1118a-02, P-4412-06</td>
</tr>
<tr>
<td>Masson–Delmotte Valérie</td>
<td>P-1102-17, P-1107-05</td>
</tr>
<tr>
<td>Masson Valéry</td>
<td>P-1115-15, P-4415-07</td>
</tr>
<tr>
<td>Mastrandrea Michael</td>
<td>O-2203-01, P-2204-04</td>
</tr>
<tr>
<td>Masui Toshihiko</td>
<td>K-4414-02, P-4414-12, P-4402-10</td>
</tr>
<tr>
<td>Mata, Érika</td>
<td>P-3305-13</td>
</tr>
<tr>
<td>Mateus Batistella</td>
<td>P-2236-08</td>
</tr>
<tr>
<td>Mather, Charles</td>
<td>P-4407-02</td>
</tr>
<tr>
<td>Mathews John</td>
<td>P-4409-23</td>
</tr>
<tr>
<td>Mathian Charlotte</td>
<td>K-2219-03, P-2219-11</td>
</tr>
<tr>
<td>Mathieu–Daudé Françoise</td>
<td>O-1111a-01</td>
</tr>
<tr>
<td>Mathilde Gralepois</td>
<td>P-3312-09, O-3337-02</td>
</tr>
<tr>
<td>Mathlouthi Majid</td>
<td>P-1119-10</td>
</tr>
<tr>
<td>Mathur, Prem Narain</td>
<td>P-2225-05</td>
</tr>
<tr>
<td>Mathy Sandrine</td>
<td>O-4401-03</td>
</tr>
<tr>
<td>Matlock Melissa</td>
<td>P-3321-12</td>
</tr>
<tr>
<td>Matos, Vanderlei</td>
<td>O-4418b-02</td>
</tr>
<tr>
<td>Matsui, Toshihisa</td>
<td>O-1116-03</td>
</tr>
<tr>
<td>Mattauch, Linus</td>
<td>P-4409-15, K-3308-03</td>
</tr>
<tr>
<td>Matt Harrison</td>
<td>P-1105-12</td>
</tr>
<tr>
<td>Matthes Katja</td>
<td>P-1108-04</td>
</tr>
<tr>
<td>Maua, James</td>
<td>O-2235-02</td>
</tr>
<tr>
<td>Maugis Pascal</td>
<td>O-4419-04</td>
</tr>
<tr>
<td>Maupin Agathe</td>
<td>O-3311-01</td>
</tr>
<tr>
<td>Mauricio Baez</td>
<td>P-1123-10</td>
</tr>
<tr>
<td>Maurizot Pierre</td>
<td>P-2210-03</td>
</tr>
<tr>
<td>Mauro, Ian</td>
<td>P-3321-15</td>
</tr>
<tr>
<td>Maury, Olivier</td>
<td>P2209-04</td>
</tr>
<tr>
<td>Maury, Pauline</td>
<td>O-1108-03, O-1108-02</td>
</tr>
<tr>
<td>Mawalagedara, R.</td>
<td>O-1113-08</td>
</tr>
<tr>
<td>May, Tony</td>
<td>O-4415a-01</td>
</tr>
<tr>
<td>May Franz</td>
<td>O-3307-03</td>
</tr>
<tr>
<td>Mays Claire</td>
<td>P-2240-13</td>
</tr>
<tr>
<td>Maystadt, Jean-François</td>
<td>P-2242-06</td>
</tr>
<tr>
<td>Mazari, Marisa</td>
<td>P-2212a-19</td>
</tr>
<tr>
<td>Mazzaud Alain</td>
<td>P-1102-10, O-1110-05</td>
</tr>
<tr>
<td>Mazaure Vincent</td>
<td>P-3303-15</td>
</tr>
<tr>
<td>Ma Zhuguo</td>
<td>K-3313-01</td>
</tr>
<tr>
<td>Mazumdar Kripaljyoti</td>
<td>P-1101-02</td>
</tr>
<tr>
<td>Mazur, Jean–Charles</td>
<td>P-1101-06</td>
</tr>
<tr>
<td>Mazzanti Massimiliano</td>
<td>O-3339-03</td>
</tr>
<tr>
<td>Mbaye Aly</td>
<td>P-2204-02</td>
</tr>
<tr>
<td>Mbaye Mamadou Lamine</td>
<td>P-3330-55</td>
</tr>
<tr>
<td>Mbow Cheik</td>
<td>K-L2.3-02, P-3328-03</td>
</tr>
<tr>
<td>Mbozi Parkie</td>
<td>P-3310-01</td>
</tr>
<tr>
<td>Mcafee Kathleen</td>
<td>K-4411-03</td>
</tr>
<tr>
<td>Mcalpine Clive</td>
<td>O-2205-01, P-2204-11</td>
</tr>
<tr>
<td>Mcbain Darian</td>
<td>O-4417-02</td>
</tr>
<tr>
<td>Mccarthy, Nancy</td>
<td>P-2240-06</td>
</tr>
<tr>
<td>Mccarthy Rachel</td>
<td>P-4419-05</td>
</tr>
<tr>
<td>Mcclain, C</td>
<td>P-4418-12</td>
</tr>
<tr>
<td>Mccollum David</td>
<td>K-3306-01, O-4402a-01, O-3322b-06, P-4402-17</td>
</tr>
<tr>
<td>Mcconnell, Joseph, R.</td>
<td>O-1103-02</td>
</tr>
<tr>
<td>Mcculloch Malcolm</td>
<td>P-1102-05</td>
</tr>
<tr>
<td>Mcdermid, Sonali</td>
<td>P-2223-18</td>
</tr>
<tr>
<td>Mcdonald Rob</td>
<td>K-4418a-01</td>
</tr>
<tr>
<td>Mcdonnell, R</td>
<td>O-1118b-05</td>
</tr>
<tr>
<td>Mcdowell, G.</td>
<td>P-3326-02</td>
</tr>
<tr>
<td>Mcevoy D.</td>
<td>K-L2.3-03</td>
</tr>
<tr>
<td>Mcglade Christophe</td>
<td>P-3322-10</td>
</tr>
<tr>
<td>Mcgray Heather</td>
<td>P-4418-13</td>
</tr>
<tr>
<td>Mcgregor Helen</td>
<td>K-1103-01</td>
</tr>
<tr>
<td>Mcguire David</td>
<td>K-1116-02</td>
</tr>
<tr>
<td>Mcguire Helen</td>
<td>K-1116-02</td>
</tr>
<tr>
<td>Mcguire Laura</td>
<td>P-3317-03</td>
</tr>
<tr>
<td>Name</td>
<td>Reference</td>
</tr>
<tr>
<td>-----------------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Melton Noel</td>
<td>(O-3315-01)</td>
</tr>
<tr>
<td>Mendelsohn, Robert</td>
<td>(P-2223-13)</td>
</tr>
<tr>
<td>Mendiratta Nisha</td>
<td>(P-4418-27, P-1123-07)</td>
</tr>
<tr>
<td>Mendoza A</td>
<td>(O-2239-11)</td>
</tr>
<tr>
<td>Menéndez Beatriz</td>
<td>(P-2231-02)</td>
</tr>
<tr>
<td>Meng Lei</td>
<td>(P-1116-12)</td>
</tr>
<tr>
<td>Mengoli, Stefano</td>
<td>(O-2207-02)</td>
</tr>
<tr>
<td>Menkes Christophe</td>
<td>(P-1111-01, P-4418-22, O-1111a-01, O-2209-01, O-1111a-02, P-1111-14, P2209-01, O-L1.5-01)</td>
</tr>
<tr>
<td>Menna Bettina</td>
<td>(P-3337-03, O-1121-01, P-1123-08)</td>
</tr>
<tr>
<td>Menon Surabi</td>
<td>(P-3311-09)</td>
</tr>
<tr>
<td>Menot, Guillemette</td>
<td>(P-1101-06)</td>
</tr>
<tr>
<td>Menut, Laurent</td>
<td>(O-1121-02)</td>
</tr>
<tr>
<td>Menzel, Lena</td>
<td>(O-2207-01)</td>
</tr>
<tr>
<td>Menzel Annette</td>
<td>(O-2213-02)</td>
</tr>
<tr>
<td>Mera Roberto</td>
<td>(P-4412-01, P-4412-06)</td>
</tr>
<tr>
<td>Mercado L.</td>
<td>(K-L1.2-05)</td>
</tr>
<tr>
<td>Mercier Alizé</td>
<td>(O-1111a-01)</td>
</tr>
<tr>
<td>Mercier Herlé</td>
<td>(O-1110-04)</td>
</tr>
<tr>
<td>Mercure Jean-François</td>
<td>(O-2237b-02, O-4420b-01)</td>
</tr>
<tr>
<td>Mercuri Anna Maria</td>
<td>(O-2241-05)</td>
</tr>
<tr>
<td>Mérian Pierre</td>
<td>(O-2216-03)</td>
</tr>
<tr>
<td>Merino-Ibarra, Martin</td>
<td>(P-2212a-19)</td>
</tr>
<tr>
<td>Meriwether Wilson</td>
<td>(O-3312-02)</td>
</tr>
<tr>
<td>Merle, Elsa</td>
<td>(P-3303-03)</td>
</tr>
<tr>
<td>Mermoz Stéphane</td>
<td>(P-2219-09)</td>
</tr>
<tr>
<td>Mertz Ole</td>
<td>(O-2218-02)</td>
</tr>
<tr>
<td>Merven Bruno</td>
<td>(O-4402-16, O-4411-01)</td>
</tr>
<tr>
<td>Mesele Samuel</td>
<td>(P-2225-10)</td>
</tr>
<tr>
<td>Mejji Alami Mohammed</td>
<td>(P-2222-06)</td>
</tr>
<tr>
<td>Mekonnenn Naod</td>
<td>(O-3309-01)</td>
</tr>
<tr>
<td>Meléndez-Ortiz Ricardo</td>
<td>(K-L4,1-02, O-4403-04)</td>
</tr>
<tr>
<td>Melet Angelique</td>
<td>(O-1110-01, P-1110-04)</td>
</tr>
<tr>
<td>Melillo, Jerry</td>
<td>(P-1114-11)</td>
</tr>
<tr>
<td>Mellado Melissa</td>
<td>(P-1123-10)</td>
</tr>
<tr>
<td>Metzger J.-M.</td>
<td>Miller Arthur</td>
</tr>
<tr>
<td>--------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Meul Stefanie</td>
<td>Miller Jonathan</td>
</tr>
<tr>
<td>Meunier, Guillaume</td>
<td>Miller Paul</td>
</tr>
<tr>
<td>Meunier Axel</td>
<td>Millet L</td>
</tr>
<tr>
<td>Meyer, Xavier</td>
<td>Mills, Jennifer</td>
</tr>
<tr>
<td>Meyer Chris</td>
<td>Milner James</td>
</tr>
<tr>
<td>Meyer Ina</td>
<td>Milne Rob</td>
</tr>
<tr>
<td>Mey Franziska</td>
<td>Mina Zamand</td>
</tr>
<tr>
<td>Meyssignac Benoit</td>
<td>Minobe Shoshiro</td>
</tr>
<tr>
<td>Meziane, Tarik</td>
<td>Minster Benoict</td>
</tr>
<tr>
<td>Michael Lazarus</td>
<td>Mintz-Woo Kian</td>
</tr>
<tr>
<td>Michael Phillips</td>
<td>Minx, Jan</td>
</tr>
<tr>
<td>Michalak, Anna</td>
<td>Miola Apollonia</td>
</tr>
<tr>
<td>Michaud Enrique</td>
<td>Miramont Cécile</td>
</tr>
<tr>
<td>Michel, Agnès</td>
<td>Mishra, Niharajan</td>
</tr>
<tr>
<td>Michela Maione</td>
<td>Mishra Santosh Kumar</td>
</tr>
<tr>
<td>Michel David</td>
<td>Mishra Saroj Kanta</td>
</tr>
<tr>
<td>Michel Elisabeth</td>
<td>Miss, Joachim</td>
</tr>
<tr>
<td>Micheli Erika</td>
<td>Mistry Malcolm</td>
</tr>
<tr>
<td>Michelot Nicolas</td>
<td>Mitchell Dann</td>
</tr>
<tr>
<td>Micou Ana Paula</td>
<td>Mitchell David</td>
</tr>
<tr>
<td>Midgley, Guy</td>
<td>Mitma Nancy</td>
</tr>
<tr>
<td>Mielke Jahel</td>
<td>Mittra, Sarika</td>
</tr>
<tr>
<td>Mignot Alexandre</td>
<td>Mi Zhifu</td>
</tr>
<tr>
<td>Mignot Juliette</td>
<td>Mkankam Kamga François</td>
</tr>
<tr>
<td>Miguel Francisco</td>
<td>Modi, Albert</td>
</tr>
<tr>
<td>Mika Janos</td>
<td>Mohamed Behnassi</td>
</tr>
<tr>
<td>Mikalitsa S. Mukhovi</td>
<td>Mohamed Meddi</td>
</tr>
<tr>
<td>Mikolajewicz Uwe</td>
<td>Mohandass Sendass</td>
</tr>
<tr>
<td>Milanovskiy Svet</td>
<td>Mohor Guilherme S.</td>
</tr>
<tr>
<td>Milcent Catherine</td>
<td>Moine Marie-Pierre</td>
</tr>
<tr>
<td>Milhomem Rodolfo</td>
<td>Moine Olivier</td>
</tr>
<tr>
<td>Miller, John B.</td>
<td></td>
</tr>
</tbody>
</table>
Morán-Tejeda, E. (P-1119-19)
Moran Dominic (P-2218-05)
Moran Miroslava (P-3312-18)
Morand Serge (K-2226-01)
Morcel Céline (O-3325b-02)
Moreira–Turcq Patricia (P-1119-12, P-1119-17, O-1119b-02)
Moreira, Nara (P-2240-02, P-2212b-01)
Moreira Marcelo (P-2218-08)
Morel, Béatrice (P-2215-10)
Morel, Jules (P-2215-08)
Morell Marc (P-2236-10)
Morel Romain (O-4404-02, P-4409-27, P-4404-02)
Morel Thierry (P-2212b-08)
Morera Julca Sergio Byron (P-1119-13)
Morgui Josep Anton (P-2217-21, P-1115-02, P-1116-08, P-1123-02)
Morhange Christophe (P-3326-13)
Mori Masato (O-1118b-04)
Morino, Isamu (K-1115-01)
Morin Pascal (O-1110-04)
Morin Samuel (O-2211-04)
Mori Shunsuke (P-2202-02, P-4402-10)
Morison James (K-L3.5-05)
Moron Vincent (P-1113-15, K-2224-04, P-2215-10, P-1113-18)
Morse Andy (P-3330-57, O-3330b-03)
Mortier Frédéric (P-2215-03, P-2216-03)
Morton John (O-2229-01, K-2229-01)
Morton Kouamé Yao (P-1102-12)
Mortyn, P. Graham (K-1103-01)
Mortsch (K-2243-03)
Mosnier, Aline (O-4402b-01, P-2214-14, O-2219-04, P-2215-07, P-3307-02)
Mosquera Kobi (O-1110-05)
# INDEX OF AUTHORS

<table>
<thead>
<tr>
<th>Author Name</th>
<th>ID Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mostegi Nina</td>
<td>O-2216-01</td>
</tr>
<tr>
<td>Motel-Combes Pascale</td>
<td>K-3308-02</td>
</tr>
<tr>
<td>Mote Philip</td>
<td>O-2245-04, P-4412-06</td>
</tr>
<tr>
<td>Mougnet Isabelle</td>
<td>P-4418-22</td>
</tr>
<tr>
<td>Mougin Eric</td>
<td>P-3330-65, P-3330-30, P-3330-35, O-3330b-02</td>
</tr>
<tr>
<td>Mouhaddach Omar</td>
<td>P-1117-27</td>
</tr>
<tr>
<td>Mouhaddach Omar</td>
<td>P-1121-04</td>
</tr>
<tr>
<td>Mouhouche Brahim</td>
<td>P-2212a-13, P-3320-17</td>
</tr>
<tr>
<td>Mounkaila Saley Moussa</td>
<td>P-1102-11</td>
</tr>
<tr>
<td>Mount, Nick</td>
<td>P-2205-11</td>
</tr>
<tr>
<td>Moutin Thierry</td>
<td>P-1111-04, P-1111-05</td>
</tr>
<tr>
<td>Moyano Fernando</td>
<td>K-1116-03</td>
</tr>
<tr>
<td>Moy Bryan</td>
<td>P-3312-10</td>
</tr>
<tr>
<td>Mubaya C.p</td>
<td>P-3328-09</td>
</tr>
<tr>
<td>Mubiru Drake</td>
<td>P-2238-08</td>
</tr>
<tr>
<td>Mudaliar Ruchi</td>
<td>O-2243-01, O-3326-01</td>
</tr>
<tr>
<td>Muudd Sekhar</td>
<td>K-2224-06</td>
</tr>
<tr>
<td>Mudliar Pranietha</td>
<td>O-2222-03</td>
</tr>
<tr>
<td>Mudliar Pranietha</td>
<td>P-2222-10</td>
</tr>
<tr>
<td>Mufwaya, Clarisse</td>
<td>P-3330-54</td>
</tr>
<tr>
<td>Mugeruzi Mas Norah</td>
<td>P-2217-14</td>
</tr>
<tr>
<td>Muhammad Usman</td>
<td>P-1123-11</td>
</tr>
<tr>
<td>Mullerman Sander</td>
<td>P-2225-11</td>
</tr>
<tr>
<td>Mukhwana Laura</td>
<td>P-2219-10</td>
</tr>
<tr>
<td>Mullan Michael</td>
<td>K-3309-02</td>
</tr>
<tr>
<td>Muller Bertrand</td>
<td>O-3330b-01, P-3330-58, P-3330-32</td>
</tr>
<tr>
<td>Muller Birgit</td>
<td>O-2211-01</td>
</tr>
<tr>
<td>Müller Christoph</td>
<td>P-2223-16, P-2217-13, K-2223-03, P-2219-13, P-2223-07, P-2218-06, O-2217-02, O-2202-02</td>
</tr>
<tr>
<td>Mulligan, Frank</td>
<td>P-1108-08</td>
</tr>
<tr>
<td>Mülmenstädt J</td>
<td>O-1122-06</td>
</tr>
<tr>
<td>Mulugetta Yacob</td>
<td>P-3316-04, O-3316-01</td>
</tr>
<tr>
<td>Munakata Shintaro</td>
<td>P-2240-15</td>
</tr>
<tr>
<td>Munaretto Stefania</td>
<td>O-3339-04</td>
</tr>
<tr>
<td>Mungai Catherine</td>
<td>P-3341-08</td>
</tr>
<tr>
<td>Munhoven Guy</td>
<td>P-2202-03</td>
</tr>
<tr>
<td>Muniz, Rodrigo</td>
<td>P-2215-05, P-2214-15</td>
</tr>
<tr>
<td>Munk Anders</td>
<td>P-4418-31</td>
</tr>
<tr>
<td>Munoz François</td>
<td>P-2215-08</td>
</tr>
<tr>
<td>Murimi Shadrack</td>
<td>P-2222-07</td>
</tr>
<tr>
<td>Murphy Conor</td>
<td>P-3312-09</td>
</tr>
<tr>
<td>Murphy Helen</td>
<td>K-2220-01</td>
</tr>
<tr>
<td>Murton Julian</td>
<td>O-1116-02</td>
</tr>
<tr>
<td>Musinguzi Laban</td>
<td>P-1123-03, P-3341-07</td>
</tr>
<tr>
<td>Musy Marjorie</td>
<td>O-2229-06</td>
</tr>
<tr>
<td>Mutabazi Khamaldin</td>
<td>P-3330-59</td>
</tr>
<tr>
<td>Mutanga Onisimo</td>
<td>P-2223-09, P-2229-05</td>
</tr>
<tr>
<td>Muthavhine Khumbelo Difference</td>
<td>P-4414-13</td>
</tr>
<tr>
<td>Mutie Ianetta</td>
<td>O-3320-03</td>
</tr>
<tr>
<td>Muttarak Raya</td>
<td>O-2240-05</td>
</tr>
<tr>
<td>Mutuma Evans</td>
<td>P-2222-07</td>
</tr>
<tr>
<td>Muuls Mirabelle</td>
<td>O-4420a-01</td>
</tr>
<tr>
<td>Muyin Wang</td>
<td>K-2209-03</td>
</tr>
<tr>
<td>Muzammil Maliha</td>
<td>O-2236-02</td>
</tr>
<tr>
<td>Mvuma, Aloys</td>
<td>P-3328-10</td>
</tr>
<tr>
<td>Mwakalila Shadrack</td>
<td>P-3328-11</td>
</tr>
<tr>
<td>Mwangu Alex Ronald</td>
<td>P-1104-07</td>
</tr>
<tr>
<td>Mwongera, Caroline</td>
<td>K-2224-04</td>
</tr>
<tr>
<td>Mwongera Caroline</td>
<td>P-2225-12</td>
</tr>
<tr>
<td>Myhre Gunnar</td>
<td>O-1122-06, P-2205-06</td>
</tr>
<tr>
<td>Mysiak Jaroslav</td>
<td>O-3322b-03</td>
</tr>
<tr>
<td>Mystakidis Stefanos</td>
<td>P-1114-05</td>
</tr>
<tr>
<td>N'danikou Sognigbe</td>
<td>P-3312-11</td>
</tr>
<tr>
<td>N'diaye Hermann Meledje</td>
<td>P-1102-12</td>
</tr>
<tr>
<td>Author Name</td>
<td>Index Numbers</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>Naab B. Jesse</td>
<td>P-3320-25</td>
</tr>
<tr>
<td>Nabet Pierre</td>
<td>O-1117-04</td>
</tr>
<tr>
<td>Nacro Soulemane</td>
<td>P-3320-06</td>
</tr>
<tr>
<td>Nadiradze Kakha</td>
<td>P-2244-03</td>
</tr>
<tr>
<td>Nagaraja Bc</td>
<td>P-3332-02</td>
</tr>
<tr>
<td>Nagashima Miyuki</td>
<td>P-4409-21</td>
</tr>
<tr>
<td>Nahian Mahin Al</td>
<td>O-3341-03</td>
</tr>
<tr>
<td>Nahuelcar, Pedro</td>
<td>P-1107-11</td>
</tr>
<tr>
<td>Naidu Vijay</td>
<td>P-1111-07</td>
</tr>
<tr>
<td>Naik Myra</td>
<td>P-2217-02</td>
</tr>
<tr>
<td>Nair Jaishanker Raghunathan</td>
<td>P-4414-14</td>
</tr>
<tr>
<td>Najafi Husain</td>
<td>O-3340-01</td>
</tr>
<tr>
<td>Najdovski Nicolas</td>
<td>O-2219-02, P-2219-11</td>
</tr>
<tr>
<td>Nakamura Hisashi</td>
<td>O-1117-01</td>
</tr>
<tr>
<td>Nakićenovic Nebojsa</td>
<td>K-2206-03</td>
</tr>
<tr>
<td>Nandkishor More</td>
<td>P-3312-12</td>
</tr>
<tr>
<td>Nand Moleen</td>
<td>P-3320-14</td>
</tr>
<tr>
<td>Nani Maya Sujakhu</td>
<td>P-1123-171</td>
</tr>
<tr>
<td>Napolitano, Giulio</td>
<td>P-4419-02</td>
</tr>
<tr>
<td>Narain Ankita</td>
<td>O-4413b-01</td>
</tr>
<tr>
<td>Narezi Gabriela</td>
<td>P-2224-18</td>
</tr>
<tr>
<td>Narisma Gemma</td>
<td>P-1117-28</td>
</tr>
<tr>
<td>Narisma Gemma Teresa</td>
<td>P-2217-30</td>
</tr>
<tr>
<td>Nascimento Nathalia</td>
<td>P-2214-16</td>
</tr>
<tr>
<td>Nasir Noor</td>
<td>P-1123-12</td>
</tr>
<tr>
<td>Nässén, Jonas</td>
<td>P-3305-13</td>
</tr>
<tr>
<td>Nassopoulos, Hypatia</td>
<td>P-4415-02</td>
</tr>
<tr>
<td>Nasuti Stephanie</td>
<td>P-2240-16</td>
</tr>
<tr>
<td>Natoli Michael</td>
<td>P-1117-04</td>
</tr>
<tr>
<td>Natugonza Vianney</td>
<td>P-1123-03</td>
</tr>
<tr>
<td>Navajas Maria</td>
<td>P-2225-13</td>
</tr>
<tr>
<td>Naveau, Philippe</td>
<td>O-1113-06</td>
</tr>
<tr>
<td>Navrozhavili Levani</td>
<td>P-2222-03</td>
</tr>
<tr>
<td>Nayak, Dali</td>
<td>P-2218-02, P-2218-03</td>
</tr>
<tr>
<td>Naznin Asha</td>
<td>O-3340-04</td>
</tr>
<tr>
<td>Nazourou Yahaya</td>
<td>P-3330-65</td>
</tr>
<tr>
<td>Ndayirukiye Sylvestre</td>
<td>P-2228-014</td>
</tr>
<tr>
<td>Ndényele Wilson</td>
<td>O-3341-01</td>
</tr>
<tr>
<td>Ndiaye, Diabel</td>
<td>K-3330b-03</td>
</tr>
<tr>
<td>Ndiaye Aminata</td>
<td>P-3313-05, O-2244-04</td>
</tr>
<tr>
<td>Ndiaye Ousmane</td>
<td>K-3330b-03</td>
</tr>
<tr>
<td>Ndinga, Roland</td>
<td>P-2214-14, P-2215-07</td>
</tr>
<tr>
<td>Ndione Jacques-Andre</td>
<td>P-3330-21</td>
</tr>
<tr>
<td>Ndiwa Nicholas</td>
<td>O-3320-03</td>
</tr>
<tr>
<td>Ndungu Anthony</td>
<td>O-3320-03</td>
</tr>
<tr>
<td>Nedelec Philippe</td>
<td>P-1105-19</td>
</tr>
<tr>
<td>Neethling Etienne</td>
<td>P-2224-21</td>
</tr>
<tr>
<td>Negev, Maya</td>
<td>O-3321-05</td>
</tr>
<tr>
<td>Neil Stuart</td>
<td>O-3312-02</td>
</tr>
<tr>
<td>Nelson Guillermo Rangel</td>
<td>O-1113-03</td>
</tr>
<tr>
<td>Nelson C. Gerald</td>
<td>P-3330-47</td>
</tr>
<tr>
<td>Nelson Erin</td>
<td>O-4417-03</td>
</tr>
<tr>
<td>Nerilie A.</td>
<td>K-L1.1-03</td>
</tr>
<tr>
<td>Nerini David</td>
<td>P2209-06</td>
</tr>
<tr>
<td>Nesarul M H</td>
<td>P-2210-05</td>
</tr>
<tr>
<td>Nesje Atle</td>
<td>P-1101-05</td>
</tr>
<tr>
<td>Neufeldt Henry</td>
<td>P-2218-02, K-2218-02</td>
</tr>
<tr>
<td>Neuhoff Karsten</td>
<td>O-4420a-05, O-4420b-01, K-2237b-01</td>
</tr>
<tr>
<td>Neukom Raphael</td>
<td>O-2211-02</td>
</tr>
<tr>
<td>Neumann, Kathleen</td>
<td>O-2219-06</td>
</tr>
<tr>
<td>Never Babette</td>
<td>P-3316-03</td>
</tr>
<tr>
<td>New Adrian L.</td>
<td>P-1113-05</td>
</tr>
<tr>
<td>Newell Peter</td>
<td>K-4409a-04</td>
</tr>
<tr>
<td>Newman Matthew</td>
<td>O-1117-01</td>
</tr>
<tr>
<td>Newton Janet</td>
<td>P-2207-04</td>
</tr>
</tbody>
</table>
INDEX OF AUTHORS

<table>
<thead>
<tr>
<th>Name</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Néya James</td>
<td>(P-3320-06)</td>
</tr>
<tr>
<td>Ngai Sheau Tieh</td>
<td>(P-1117-28)</td>
</tr>
<tr>
<td>Ngang Eric</td>
<td>(P-3328-12)</td>
</tr>
<tr>
<td>Ngo-Duc Thanh</td>
<td>(P-1117-28)</td>
</tr>
<tr>
<td>Ngonzo Luwesi Cush</td>
<td>(P-3301-06, P-4414-15)</td>
</tr>
<tr>
<td>Nguyen Trinh Hoang Anh</td>
<td>(P-3303-17, P-3303-16)</td>
</tr>
<tr>
<td>Nguyen–Xuan Thanh</td>
<td>(P-1117-28)</td>
</tr>
<tr>
<td>Nguyen Bruno</td>
<td>(O-2229-05)</td>
</tr>
<tr>
<td>Nguyen Huy</td>
<td>(P-2212b-11)</td>
</tr>
<tr>
<td>Nguyen Thi Minh, Tu</td>
<td>(P-1115-07)</td>
</tr>
<tr>
<td>Ngwadla X.</td>
<td>(K-L4.5-03)</td>
</tr>
<tr>
<td>Nhantumbo, Isilda</td>
<td>(K-2220-03)</td>
</tr>
<tr>
<td>Nhutrang Tran Thi</td>
<td>(O-1111b-04)</td>
</tr>
<tr>
<td>Niang Coumba</td>
<td>(P-3328-13)</td>
</tr>
<tr>
<td>Niboyet Audrey</td>
<td>(P-1116-13)</td>
</tr>
<tr>
<td>Nicholas Kimberly</td>
<td>(P-1123-12)</td>
</tr>
<tr>
<td>Nicholas Kyei-Baffour</td>
<td>(P-3330-50)</td>
</tr>
<tr>
<td>Nicholls Robert</td>
<td>(K-L3.5-01, O-2210-02, K-2243-01, K-2210-02)</td>
</tr>
<tr>
<td>Nicholson, Sharon</td>
<td>(P-3330-68)</td>
</tr>
<tr>
<td>Nick W.</td>
<td>(K-L1.4-02)</td>
</tr>
<tr>
<td>Nickus U</td>
<td>(P-1101-04)</td>
</tr>
<tr>
<td>Nicmic, Jean</td>
<td>(P-2219-01)</td>
</tr>
<tr>
<td>Nicolea–Lerma Alexandre</td>
<td>(P-2210-03)</td>
</tr>
<tr>
<td>Nicolas Claire</td>
<td>(P-2236-15, P-4418-23)</td>
</tr>
<tr>
<td>Nicol Simon</td>
<td>(O-2209-01, P2209-01)</td>
</tr>
<tr>
<td>Nidheesh, A.g.</td>
<td>(K-1111a-02, K-L1.5-02)</td>
</tr>
<tr>
<td>Nieters, Anne</td>
<td>(K-3309-03)</td>
</tr>
<tr>
<td>Nifenecker Hervé</td>
<td>(P-3302-02)</td>
</tr>
<tr>
<td>Nightingale Joanne</td>
<td>(P-2219-11)</td>
</tr>
<tr>
<td>Nikiëma Philippe</td>
<td>(P-3320-06)</td>
</tr>
<tr>
<td>Nikolic Igor</td>
<td>(O-4408-01)</td>
</tr>
<tr>
<td>Nikulin, Grigory</td>
<td>(O-3303-01)</td>
</tr>
<tr>
<td>Nilsson Lars J.</td>
<td>(O-3305-06)</td>
</tr>
<tr>
<td>Njenga Mary</td>
<td>(O-2235-01)</td>
</tr>
<tr>
<td>Nkona E.</td>
<td>(K-L3.5-04)</td>
</tr>
<tr>
<td>Nkrumah Francis</td>
<td>(P-3330-60, P-1113-08)</td>
</tr>
<tr>
<td>Nkue Nouwezem Daniel Jude</td>
<td>(P-3328-14)</td>
</tr>
<tr>
<td>Nkwanga David</td>
<td>(P-3330-61)</td>
</tr>
<tr>
<td>Noailly Joëlle</td>
<td>(K-4413b-01)</td>
</tr>
<tr>
<td>Nolop, Eloi Dalla</td>
<td>(O-3303-01)</td>
</tr>
<tr>
<td>Nolopoulos, Issam</td>
<td>(P-2219-11)</td>
</tr>
<tr>
<td>Nolden Colin</td>
<td>(P-4413-05)</td>
</tr>
<tr>
<td>Noli Da Fonseca Murilo</td>
<td>(P-1117-29)</td>
</tr>
<tr>
<td>Nolop, Eloi Dalla</td>
<td>(P-2219-11)</td>
</tr>
<tr>
<td>Nolopoulos, Issam</td>
<td>(P-2219-11)</td>
</tr>
<tr>
<td>Normatov Inom</td>
<td>(P-2211-08)</td>
</tr>
<tr>
<td>Normatov Parviz</td>
<td>(P-4418-24)</td>
</tr>
<tr>
<td>Norby, Richard J</td>
<td>(P-1116-14, P-2215-04)</td>
</tr>
<tr>
<td>Nordensvard Johan</td>
<td>(O-4413b-01)</td>
</tr>
<tr>
<td>Nordkvelle, Jonas</td>
<td>(P-3340-01)</td>
</tr>
<tr>
<td>Noriega Luís</td>
<td>(K-1119a-02)</td>
</tr>
<tr>
<td>Nofuentes Ramos Manel</td>
<td>(P-2217-21, P-1116-08)</td>
</tr>
<tr>
<td>Nogueira José Amaro</td>
<td>(P-1117-31)</td>
</tr>
<tr>
<td>Nolasco Camille</td>
<td>(P-3320-18, P-2240-09)</td>
</tr>
<tr>
<td>Nolop, Eloi Dalla</td>
<td>(O-3303-01)</td>
</tr>
<tr>
<td>Nolopoulos, Issam</td>
<td>(P-2219-11)</td>
</tr>
<tr>
<td>Nolop, Eloi Dalla</td>
<td>(P-2219-11)</td>
</tr>
</tbody>
</table>
Odindi John (P-2229-05)
Odini John (P-2223-09)
Odongkara Konstantine (P-1123-03)
Odoulami Romaric Christel (P-3301-07)
Oduor Nellie (O-2235-02)
Oelbermann, Maren (P-3320-04)
Oettle Noel (P-2239-08)
Offenthaler, Ivo (O-2203-03)
Ogallo Edith (P-3312-15)
Ogallo Laban (P-1102-09)
Ogbonnaya Onyinyechi (P-2216-09)
Oglesby Robert (O-1113-08)
Ogouwale Romaric (P-3330-62)
Ogunjobi Kehinde O (P-1117-47)
Ogunmola Olabanji (P-2225-01)
Ogutu-Ohwayo Richard (P-1123-03, P-3341-07)
Ojeda Hernan (P-2224-21)
Ojima Dennis (K-2224-01, K-1105b-02)
Okada Masashi (P-2204-17)
Okello William (P-1123-03)
Oke Michael (P-2224-20)
Okereke Chukwumerije (O-4411-03)
Okiri Elizabeth (P-2235-03)
Oki Taikan (K-L2.5-03, P-2204-17, P-2202-05, K-2212a-01)
Okoh Augustine I. Sadiq (P-3328-15)
Okojie Monday Uijaakhien (P-4414-16)
Okonkwo, Churchill (O-1116-03)
Okorie Fidelis (P-1117-30)
Okorie Victor (P-2238-02)
Okot Michael (K-3312-01, P-2235-03)
Olayinka (Okoro) Elizabeth (P-3330-63)
Oleson, Keith (P-2204-01)
<table>
<thead>
<tr>
<th>Index of Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Olin, Stefan (P-2217-25, P-2223-07)</td>
</tr>
<tr>
<td>Oliveira Sa Sandra (P-1117-31)</td>
</tr>
<tr>
<td>Oliveira–Miranda Maria A. (O-2238-04)</td>
</tr>
<tr>
<td>Oliveros Carlos (P-4418-19)</td>
</tr>
<tr>
<td>Olivie D.j.l (O-1122-06)</td>
</tr>
<tr>
<td>Ollat Nathalie (P-2224-21)</td>
</tr>
<tr>
<td>Olorunfemi Felix (P-2244-04)</td>
</tr>
<tr>
<td>Oloukoï Grace (P-2244-04)</td>
</tr>
<tr>
<td>Olson David (P-2214-01)</td>
</tr>
<tr>
<td>Omay Joinville (P-1123-13)</td>
</tr>
<tr>
<td>Omdp Members With (P-1106-04)</td>
</tr>
<tr>
<td>Ometto Jean (P-2215-09, P-3320-18, P-2215-04)</td>
</tr>
<tr>
<td>Omotosho Jerome A. (P-1117-41)</td>
</tr>
<tr>
<td>Ongolo Zogo Valérie (K-4415a-01)</td>
</tr>
<tr>
<td>Onwuemele Andrew (P-2232-03)</td>
</tr>
<tr>
<td>Onyango, Leah (P-2225-16)</td>
</tr>
<tr>
<td>Onyige Chioma Daisy (P-3341-09)</td>
</tr>
<tr>
<td>Op De Beek Maarten (P-1115-07)</td>
</tr>
<tr>
<td>Oppo, Delia (K-1103-01)</td>
</tr>
<tr>
<td>Orazio Christophe (K-L3.5-05)</td>
</tr>
<tr>
<td>Ordoñez, J (P-3328-17)</td>
</tr>
<tr>
<td>Orekan Vincent (P-3330-65)</td>
</tr>
<tr>
<td>Oreskes Naomi (K-4412-02, O-1114-02)</td>
</tr>
<tr>
<td>Oreszczyn Tadz (P-3321-17)</td>
</tr>
<tr>
<td>Orignac Jadwiga (P-2208-03)</td>
</tr>
<tr>
<td>Origo Niall (P-2219-11)</td>
</tr>
<tr>
<td>Orindí Victor (P-4409-28)</td>
</tr>
<tr>
<td>Ormeno E. (O-3326-03)</td>
</tr>
<tr>
<td>Orphal, Johannes (P-1108-06)</td>
</tr>
<tr>
<td>Orsolini Yvan J. (P-1108-04)</td>
</tr>
<tr>
<td>Ortega, Enrique (P-2240-07)</td>
</tr>
<tr>
<td>Ortega Pablo (P-1102-17, K-L1.1-02)</td>
</tr>
<tr>
<td>Orth Rene (O-1118a-03)</td>
</tr>
<tr>
<td>Ortmann, Gerald (O-2240-03)</td>
</tr>
<tr>
<td>Orts J.-P. (O-3326-03)</td>
</tr>
<tr>
<td>Osborn David (P-2207-02)</td>
</tr>
<tr>
<td>Osborne B. (P-1115-04)</td>
</tr>
<tr>
<td>Osborne Tom (P-2233-03)</td>
</tr>
<tr>
<td>Oschlies Andreas (P-1111-08, O-1110-05)</td>
</tr>
<tr>
<td>Ostergaard Jens (P-4414-17)</td>
</tr>
<tr>
<td>Oszwald Johan (P-3330-65, O-2215-01)</td>
</tr>
<tr>
<td>Otávio Do Canto (P-2236-08)</td>
</tr>
<tr>
<td>Ota Yoshitaka (K-2209-04)</td>
</tr>
<tr>
<td>Otieno George (P-3328-16, P-1121-10, P-4410-05, P-2225-14)</td>
</tr>
<tr>
<td>Otte Im Kampe Eveline (P-1121-11)</td>
</tr>
<tr>
<td>Ott Hermann (P-4409-29)</td>
</tr>
<tr>
<td>Otto Christian (O-2237a-03)</td>
</tr>
<tr>
<td>Otto Friederieke (P-1118a-01, O-1118a-02, O-1104-05, O-1118b-05, P-4412-07, P-2204-06, P-4412-06)</td>
</tr>
<tr>
<td>Otto Friederieke (P-2240-17)</td>
</tr>
<tr>
<td>Otto Matthias (P-2204-07)</td>
</tr>
<tr>
<td>Otzelberger Agnes (P-4414-09)</td>
</tr>
<tr>
<td>Oudar Thomas (P-1102-13)</td>
</tr>
<tr>
<td>Ouédraogo Dakis–Yaoba (P-2215-03)</td>
</tr>
<tr>
<td>Ouédraogo François De Charles (P-3330-22)</td>
</tr>
<tr>
<td>Ouédraogo Léonard (P-3320-06)</td>
</tr>
<tr>
<td>Oueslati Boutheina (P-1113-15, P-1113-18)</td>
</tr>
<tr>
<td>Ouhamdouch Salah (P-2212a-15)</td>
</tr>
<tr>
<td>Ouillon Sylvain (O-1111b-02)</td>
</tr>
<tr>
<td>Oukabli Ahmed (P-3326-03)</td>
</tr>
<tr>
<td>Ourcival, Jean–Marc (P-3326-04)</td>
</tr>
<tr>
<td>Ousmane Ndiaye (P-2217-28)</td>
</tr>
<tr>
<td>Ovcharuk Valeriya (P-1119-14)</td>
</tr>
<tr>
<td>Ovuyowwiroye Odjugo (O-3340-03)</td>
</tr>
<tr>
<td>Owen Lewis (P-1101-05)</td>
</tr>
<tr>
<td>Oyuela, Marcelo (P-3312-18)</td>
</tr>
<tr>
<td>Author Name</td>
</tr>
<tr>
<td>----------------------------------</td>
</tr>
<tr>
<td>Ozer Pierre</td>
</tr>
<tr>
<td>Ozturk, Tugba</td>
</tr>
<tr>
<td>P. Ndiaye</td>
</tr>
<tr>
<td>Pabi Opoku</td>
</tr>
<tr>
<td>Pacala Steven</td>
</tr>
<tr>
<td>Pachauri Shonalie</td>
</tr>
<tr>
<td>Pacheco Mollinedo Paula Lady</td>
</tr>
<tr>
<td>Pacheco-Magaña, Lilian</td>
</tr>
<tr>
<td>Pacheco, Felipe Siqueira</td>
</tr>
<tr>
<td>Pacifici, M.</td>
</tr>
<tr>
<td>Pacteau Chantal</td>
</tr>
<tr>
<td>Padakandla Steven Raj</td>
</tr>
<tr>
<td>Pagé Christian</td>
</tr>
<tr>
<td>Pagunsan Junelyn</td>
</tr>
<tr>
<td>Pagunsan Marmon</td>
</tr>
<tr>
<td>Pahle Michael</td>
</tr>
<tr>
<td>Pahl Sabine</td>
</tr>
<tr>
<td>Paillès C</td>
</tr>
<tr>
<td>Painter James</td>
</tr>
<tr>
<td>Pairaud Ivane</td>
</tr>
<tr>
<td>Pairojmahakij Regan</td>
</tr>
<tr>
<td>Paje Philip Michael</td>
</tr>
<tr>
<td>Palany Philippe</td>
</tr>
<tr>
<td>Palazzi Elisa</td>
</tr>
<tr>
<td>Palazzo Amanda</td>
</tr>
<tr>
<td>Palerme Cyril</td>
</tr>
<tr>
<td>Palmer, Margaret</td>
</tr>
<tr>
<td>Palmer Matt</td>
</tr>
<tr>
<td>Palve Sandip</td>
</tr>
<tr>
<td>Pan, Shufen</td>
</tr>
<tr>
<td>Pandey Bindhy Wasini</td>
</tr>
<tr>
<td>Panthi Jeeban</td>
</tr>
<tr>
<td>Panthou Gérémynes</td>
</tr>
<tr>
<td>Pan Zaitao</td>
</tr>
<tr>
<td>Paoletti Elena</td>
</tr>
<tr>
<td>Papadimitriou Lamprini</td>
</tr>
<tr>
<td>Papa Fabrice</td>
</tr>
<tr>
<td>Papageorgiou Nafsika</td>
</tr>
<tr>
<td>Papale, Dario</td>
</tr>
<tr>
<td>Paramana Theo</td>
</tr>
<tr>
<td>Pardoe Joanna</td>
</tr>
<tr>
<td>Pardon Lenaic</td>
</tr>
<tr>
<td>Paresh Bhaskar</td>
</tr>
<tr>
<td>Parey Sylvie</td>
</tr>
<tr>
<td>Parida Jayashree</td>
</tr>
<tr>
<td>Parinos Constantine</td>
</tr>
<tr>
<td>Paris, Jean Daniel</td>
</tr>
<tr>
<td>Paris François</td>
</tr>
<tr>
<td>Park Cheol-Hong</td>
</tr>
<tr>
<td>Parker, John</td>
</tr>
<tr>
<td>Parkes Ben</td>
</tr>
<tr>
<td>Park Jin-Hee</td>
</tr>
<tr>
<td>Park Ju-Hyoung</td>
</tr>
<tr>
<td>Park Se-Joon</td>
</tr>
<tr>
<td>Parrado Ramiro</td>
</tr>
<tr>
<td>Parrod Camille</td>
</tr>
<tr>
<td>Parr Terry</td>
</tr>
<tr>
<td>Parsons Mark</td>
</tr>
<tr>
<td>Parthasarathi Theivasigamani</td>
</tr>
<tr>
<td>Parvathi, V</td>
</tr>
<tr>
<td>Pascual, D.</td>
</tr>
<tr>
<td>Pasqui Massimiliano</td>
</tr>
<tr>
<td>Pasquini, Luca</td>
</tr>
<tr>
<td>Pastor A.v.</td>
</tr>
</tbody>
</table>
INDEX OF AUTHORS

Pata Patrick (P2209-07)
Paterne Martine (P-1102-10, O-1110-05)
Patra Dharani Dhar (P-2224-23)
Patra Jyotiraj (P-2239-10)
Patricia Pinho (P-2236-08)
Patris, Nicolas (P-3330-13)
Pattanayak Shobhana Kumar (P-4406-05)
Pattberg Philipp (O-4410-01)
Paturel Jean-Emmanuel (P-3330-28, O-3330a-02, P-2212a-05, O-1119b-05)
Patwardhan Anand (P-3302-03)
Paudel, Rajendra (P-1116-12)
Paudel Shiba (P-4405-04)
Paula M.carreira (P-2212a-15)
Paul Arya (P-1116-04)
Pauline Noah Makula (P-3312-17)
Paulmier Aurélien (O-1115-04)
Paulmier Aurélien (O-1110-05)
Paulo Nobre (P-2245-05)
Pauw Pieter (O-4410-01, O-4407-02, O-3310-04)
Pavageau, Charlotte (O-3331-03)
Pavlova Irina (P-2211-05)
Payen G. (P-1105-03)
Payne Tony (P-2204-10)
Payoshni Samantray (P-1113-17)
Payri Claude (O-1111b-01)
Paz Shlomit (O-3321-05)
Pearce–Kelly, P. (O-4418b-01)
Pearce, T (P-3326-02, P-3321-15)
Pearson, R. (O-4418b-01)
Pearson Nakia (O-2242-07)
Pedinotti Vanessa (P-3330-33)
Pegels Anna (K-4410-02, P-3316-04)
Peiry J–L (O-3331-02)
Pellens Roseli (P-2214-18)
Pellerin Sylvain (P-2218-05)
Pelletier Bernard (O-1111b–03)
Pelletier Johanne (P-2219-05)
Pelling, Mark (P-2203-02)
Pelte Thomas (O-3325b–01)
Pena Claros Marielos (O-2244-01)
Penalba, Olga Clarinda (P-1102–15)
Pena Sergio (P-2203-02)
Penduff Thierry (O-1117-03)
Peng, Roger (P-2204-01)
Penven Pierrick (P-1111-12)
Peou Rathana (O-2236-02)
Perdana Putri Intan Adhi (O-2229-03)
Peregon Anna (P-1114-02)
Pereira, V. (P-2212b–02)
Perez Cruz Ligia (P-1117-03)
Perez Soba Marta (O-2244-01)
Perez, Fiz F. (O-1110-04)
Perez, Joel (P-3312-18)
Pérez Cristian Hernán Cabrera (P-4402-07)
Perez John Edward G (P-2217-30)
Perga Me (K-1101-03)
Perkins, Sarah (O-1113-01, P-1118-06)
Perks Matthew (P-3316-06)
Permafrost Carbon Network . (P-1116-01)
Perrin Charles (K-2212b–03)
Perrin Lola (P-4410-06)
Perrin Nathalie (O-2242-02)
Perroud Marjorie (P-2211-03)
Perrussel Olivier (P-1115-15)
Perry Miles (O-4402a–02, O-2237a–01, P-3303-22)
Alphabetic Index of Authors

Alphabetical list of authors contributing to the conference proceedings.
# INDEX OF AUTHORS

<table>
<thead>
<tr>
<th>Author Name</th>
<th>Page(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pla, E.</td>
<td>(P-1119-19)</td>
</tr>
<tr>
<td>Pla C.</td>
<td>(P-1115-01)</td>
</tr>
<tr>
<td>Place F.</td>
<td>(K-L3.5-04)</td>
</tr>
<tr>
<td>Plantinga Andrew</td>
<td>(O-2245-04)</td>
</tr>
<tr>
<td>Planton Serge</td>
<td>(P-1104-09, O-2232-03)</td>
</tr>
<tr>
<td>Platt Ulrich</td>
<td>(O-3301-01)</td>
</tr>
<tr>
<td>Plugge Daniel</td>
<td>(P-2219-12, P-3331-03)</td>
</tr>
<tr>
<td>Plunkett, Gill</td>
<td>(O-1103-02)</td>
</tr>
<tr>
<td>Poan Emmanuel D</td>
<td>(P-3330-66)</td>
</tr>
<tr>
<td>Pockelé Luc</td>
<td>(P-3305-17)</td>
</tr>
<tr>
<td>Poelina Anne</td>
<td>(K-2238-01)</td>
</tr>
<tr>
<td>Poeydebat Charlotte</td>
<td>(O-3330b-01, P-3330-32)</td>
</tr>
<tr>
<td>Poher Yoann</td>
<td>(O-1101-03)</td>
</tr>
<tr>
<td>Pohl Benjamin</td>
<td>(P-1113-15, P-1113-18)</td>
</tr>
<tr>
<td>Pokam Wilfried</td>
<td>(P-1117-34)</td>
</tr>
<tr>
<td>Pokharel Navaraj</td>
<td>(P-2230-04)</td>
</tr>
<tr>
<td>Polanco Josue</td>
<td>(K-2237a-03)</td>
</tr>
<tr>
<td>Polcher Jan</td>
<td>(O-1119b-01)</td>
</tr>
<tr>
<td>Policelli, Frederick</td>
<td>(O-1116-03)</td>
</tr>
<tr>
<td>Pollard Sharon</td>
<td>(O-4414-03)</td>
</tr>
<tr>
<td>Pollitt, Hector</td>
<td>(O-2237b-02)</td>
</tr>
<tr>
<td>Poloczanska E.</td>
<td>(K-L1.3-03)</td>
</tr>
<tr>
<td>Pommeret, Aude</td>
<td>(P-2202-01)</td>
</tr>
<tr>
<td>Ponater Michael</td>
<td>(P-1108-05)</td>
</tr>
<tr>
<td>Ponce De Leon Barido Diego</td>
<td>(P-1123-034)</td>
</tr>
<tr>
<td>Ponce Roberto Daniel</td>
<td>(P-3320-11)</td>
</tr>
<tr>
<td>Poncet Laurent</td>
<td>(P-2208-01)</td>
</tr>
<tr>
<td>Pongratz J.</td>
<td>(K-L1.2-04)</td>
</tr>
<tr>
<td>Ponsonnet Cedric</td>
<td>(P-1111-13)</td>
</tr>
<tr>
<td>Pontaud Marc</td>
<td>(P-1105-19)</td>
</tr>
<tr>
<td>Poortinga Wouter</td>
<td>(P-2240-18, O-2240-01)</td>
</tr>
<tr>
<td>Popp Alexander</td>
<td>(P-2217-13, P-2219-13, P-2218-06, O-2217-02, K-2217-03, K-2217-01)</td>
</tr>
<tr>
<td>Popp David</td>
<td>(P-3303-21)</td>
</tr>
<tr>
<td>Poppe, Marcelo</td>
<td>(P-4402-04, P-1115-10, O-3317-02)</td>
</tr>
<tr>
<td>Porcher Emmanuelle</td>
<td>(P-2224-07)</td>
</tr>
<tr>
<td>Porembski Stefan</td>
<td>(O-2244-02)</td>
</tr>
<tr>
<td>Portafaix T.</td>
<td>(P-1105-03)</td>
</tr>
<tr>
<td>Portella Maria Celia</td>
<td>(P-2213-03)</td>
</tr>
<tr>
<td>Portenart Philomène</td>
<td>(O-4420b-03)</td>
</tr>
<tr>
<td>Porter James</td>
<td>(K-2239-01)</td>
</tr>
<tr>
<td>Pörtner Hans–Otto</td>
<td>(O-2207-01, K-L1.3-02)</td>
</tr>
<tr>
<td>Posadas Adolfo</td>
<td>(P-1117-35)</td>
</tr>
<tr>
<td>Posny F.</td>
<td>(P-1105-03)</td>
</tr>
<tr>
<td>Poteau Antoine</td>
<td>(P-1111-03, P-1111-13)</td>
</tr>
<tr>
<td>Pottier Antonin</td>
<td>(P-4412-05)</td>
</tr>
<tr>
<td>Potts Andrew</td>
<td>(O-2231-05)</td>
</tr>
<tr>
<td>Potts Keith</td>
<td>(P-1117-36)</td>
</tr>
<tr>
<td>Potvin, Catherine</td>
<td>(O-2219-05)</td>
</tr>
<tr>
<td>Poudyal, Bishnu</td>
<td>(O-2220-02)</td>
</tr>
<tr>
<td>Poudyal, Mahesh</td>
<td>(P-2219-07)</td>
</tr>
<tr>
<td>Poudyal, Rajesh</td>
<td>(O-1116-03)</td>
</tr>
<tr>
<td>Pouget, Laurent</td>
<td>(K-L3.5-08)</td>
</tr>
<tr>
<td>Poulain, Virgin</td>
<td>(O-1103-05)</td>
</tr>
<tr>
<td>Poulencard J</td>
<td>(K-1101-03)</td>
</tr>
<tr>
<td>Poulet Nicolas</td>
<td>(O-2213-01)</td>
</tr>
<tr>
<td>Poulos Serafim</td>
<td>(P-4409-22)</td>
</tr>
<tr>
<td>Poulter Benjamin</td>
<td>(O-2219-02, P-1114-02, P-1114-11, P-2219-11)</td>
</tr>
<tr>
<td>Poumadere Marc</td>
<td>(P-2240-13)</td>
</tr>
<tr>
<td>Pouyaud, Bernard</td>
<td>(P-1107-11)</td>
</tr>
<tr>
<td>Powell F</td>
<td>(P-2201-03)</td>
</tr>
<tr>
<td>Powell George</td>
<td>(P-2214-01)</td>
</tr>
<tr>
<td>Power Scott</td>
<td>(K-L111a-03, K-L1.5-03)</td>
</tr>
<tr>
<td>Prada Fiorella</td>
<td>(O-2207-02)</td>
</tr>
<tr>
<td>Pradhan Or Mathur Gireesh Or Ajay</td>
<td>(O-3304-06)</td>
</tr>
</tbody>
</table>
Purse, Bethan (O-2244-01)
Purser Autun (K-2208-03)
Pycroft Jonathan (O-2237a-01, P-2219-04)
Pyle John (P-1108-02)

Q
Qi Shaozhou (P-4420-02)
Qiu, Bo (O-1110-01)
Qu, Tangdong (O-1110-01)
Quaas J (O-1122-06)
Quail Sheryl (P-2225-16)
Quantin, Guillaume (P-3330-33)
Quartieri Giuseppe (P-2239-03, P-3306-04, P-1121-03)
Quegan Shaun (P-1105-09)
Quenel Simon (O-4420b-05)
Quenel Philippe (P-2226-02)
Quenol Herve (O-3320-03)
Querion Philippe (O-3337-02, P-3330-32)
Quiros Carlos (O-3320-03)
Quiroz Roberto (P-1117-35)
Quispe Jorge (O-1110-05)

R
R. F. Belen (P-3330-21)
Raadgever, Tom (P-3337-01)
Raad Rodrigo (P-2233-01, P-2240-08)
Rabatel Antoine (O-2211-05, P-1105-17)
Rabeharisoa Lilia (P-3325-02)
Racelis, Diomedes (P-1115-11, O-2233-05)
INDEX OF AUTHORS

Racelis Elenita (P-1115-11, O-2233-05)
Rachel McCravy (K-1104-01)
Radeny Maren (P-2238-08, O-3320-03)
Rafolisy Tovonarivo (P-3325-02)
Rafols, Ismael (P-4418-12)
Raga, Graciela B. (P-2212a-22)
Rageade Maxence (P-2219-11)
Rahaman Muhammad Abdur (P-2225-17)
Rahman Andaleeb (O-2222-03, P-2222-10)
Rahman Ashikur (P-2233-05)
Rahman Md. Alimu (P-2225-18)
Rahman Mofizur (P-2212a-16)
Rahmstroff Stefan (O-1110-03, O-1122-04)
Raible CC. (K-L1.1-02)
Rajapaksha. I (P-3305-14)
Rajapaksha Upendra (P-3305-14)
Rajaud Amelie (O-2222-04)
Rajot Jean Louis (P-3330-01)
Rakotonarivo Sarobidy (P-2219-07)
Rakotosamimanana Stéphan (O-2218-03)
Rakotovao Narindra (O-2218-03)
Ramamonjisoa Bruno (P-2219-07)
Ramankutty Navin (P-2223-06)
Ramarohetra Johanna (P-3330-35)
Ramírez-Villegas Julian (P-3330-67)
Ramírez-Zierold, Jorge (P-2212a-19)
Rammig Anja (O-2204-04, P-2215-04)
Ramonet M. (P-1105-03, P-1115-12, P-1105-14, P-1115-03)
Ramos Fabien (P-2223-17)
Ramos Fernando M. (P-2214-14, O-2219-04, P-2219-02)
Ramstein Céline (O-4410-01)
Ramstein Gilles (O-2242-03, O-1102-04)
Rana, Prabina (P-2214-02)
Rao, Shilpa (O-1121-02, O-3322b-06)
Rao Anand B (P-3302-03, P-3303-20)
Rao Narasimha (K-L2.1-02, P-1123-178, O-4406a-04, K-4406b-03, O-4406b-01, P-3305-11)
Rashed Mnageeb (P-2212a-17)
Rasiah Rajah (P-4409-01)
Rasoamanana Alexandra (P-2219-07)
Rasul Ghulam (P-2223-19)
Ratier Alain (K-1105a-01)
Ratinger Tomas (P-3320-07)
Rauch Marc (P-1115-14)
Raucoules Daniel (P-1107-13)
Rault, Bertrand (O-4417-03)
Raux Charles (P-3316-07)
Ravetta François (P-1115-15)
Rayner Mike (O-3320-01)
Rayner Tim (P-2205-05)
Razafimbelo Tantely M. (O-3325b-03, P-3325-02, O-2218-03)
Razakamanarivo Herintsitonaina (O-3325b-03, P-3325-02)
Razakaratrimo Joyce (O-2218-03)
Reason, Chris (P-1111-12)
Reber Bernard (P-4409-31)
Rebetez Martine (P-1117-38)
Rebolledo Ignacio (K-L4.4-03)
Rech John (P-2225-16)
Rech John (P-2238-08)
Recous Sylvie (P-2218-05)
Redford, Ellen (P-1123-12)
Redi Robert (P-1117-41)
Regimbeau Fabienne (P-2212b-08)
Regmi Ram Prasad (P-1121-12)
INDEX OF AUTHORS

International Scientific Conference     7-10 JULY 2015    PARIS, FRANCE

O-3322b-06, P-4402-17, K-2206-04

Ribera Teresa (O-4403-05)

Ribereau Pierre (O-4408-06)

Ribes Aurélien (O-1118b-03)

Ribstein Pierre (O-3330a-02, O-1119b-05)

Ricardo Beto (O-2238-04)

Richard Lalou (P-3330-58)

Richards Meryl (O-1115-03)

Richard Yves (O-2201-01)

Richet, Sebastien (P-3302-02)

Richet, Yann (P-3303-03)

Ricke, Kate (P-3301-05)

Ricome, Aymeric (P-3330-32)

Riemann–Campe Kathrin (O-1112-02)

Riese, Martin (P-1108-06)

Rietig Katharina (P-4409-32)

Rigolot Eric (P-3326-10)

Riley William J. (P-1116-07, K-1116-02)

Rimet F (K-1101-03)

Ringor, Cherry (P2209-05)

Rios Aida F. (O-1110-04)

Rios Sandra (O-2238-04)

Rishi Parul (O-2243-01, P-2240-19)

Rivera Juan Antonio (P-1102-15)

Rivero, S, (P-2212b-01)

Rivero, Sergio (P-2240-02, P-2240-22)

Rivier, Leonard (O-1115-01, P-1115-12, P-1105-14)

Rivière Béatrice (P-2208-03)

Rixen, Christian (P-1117-38)

Rizopoulos Yorgos (P-3303-17)

Rizzo, L.v. (P-221501)

Roa, Javiera (P-1123-10)

Robert Marc (P-2236-06)
## INDEX OF AUTHORS

<table>
<thead>
<tr>
<th>Name</th>
<th>Reference(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roberto Araújo</td>
<td>P-2236-08</td>
</tr>
<tr>
<td>Robert Prisca</td>
<td>P-1102-10</td>
</tr>
<tr>
<td>Roberts, Jason</td>
<td>P-1107-06</td>
</tr>
<tr>
<td>Roberts, Olga</td>
<td>P-3316-01</td>
</tr>
<tr>
<td>Roberts Erin</td>
<td>P-4406-08</td>
</tr>
<tr>
<td>Robertson, Richard</td>
<td>O-2217-01</td>
</tr>
<tr>
<td>Robertson Eddy</td>
<td>P-2217-23</td>
</tr>
<tr>
<td>Robida François</td>
<td>P-1105-12, P-4418-09</td>
</tr>
<tr>
<td>Robineau Bernard</td>
<td>P-2210-03</td>
</tr>
<tr>
<td>Robine Jean-Marie</td>
<td>O-2226-04</td>
</tr>
<tr>
<td>Robins N.</td>
<td>K-L4.1-03</td>
</tr>
<tr>
<td>Robinson, Alex</td>
<td>O-1110-03, O-4406b-04</td>
</tr>
<tr>
<td>Robinson Darren</td>
<td>K-2229-03</td>
</tr>
<tr>
<td>Robinson Sherman</td>
<td>O-3320-01</td>
</tr>
<tr>
<td>Robiou Du Pont Yann</td>
<td>P-4412-03, P-4412-08</td>
</tr>
<tr>
<td>Roblou Laurent</td>
<td>O-3318-02</td>
</tr>
<tr>
<td>Robock Alan</td>
<td>P-2223-22, P-1123-038</td>
</tr>
<tr>
<td>Rocha, Marcelo</td>
<td>P-1115-10</td>
</tr>
<tr>
<td>Rocha Marcia Rosa</td>
<td>O-4412-01</td>
</tr>
<tr>
<td>Rockov, Joacim</td>
<td>O-3321-03</td>
</tr>
<tr>
<td>Rockström Johan</td>
<td>K-4406b-02, K-2206-02, O-2204-03</td>
</tr>
<tr>
<td>Rodary Estienne</td>
<td>P-1111-07</td>
</tr>
<tr>
<td>Rödder, Simone</td>
<td>P-4418-28</td>
</tr>
<tr>
<td>Roddy Michael</td>
<td>O-4419-06</td>
</tr>
<tr>
<td>Rodier, Martine</td>
<td>P-1111-13, P-1111-14</td>
</tr>
<tr>
<td>Rodolfo–Metalpa Riccardo</td>
<td>O-1111b-01</td>
</tr>
<tr>
<td>Rodó Xavier</td>
<td>P-3321-10, P-2217-21, P-1116-08, O-2226-04, P-1123-02</td>
</tr>
<tr>
<td>Rodrigues Nuno</td>
<td>P-4409-22</td>
</tr>
<tr>
<td>Rodriguez Daniel</td>
<td>P-2212a-18</td>
</tr>
<tr>
<td>Roedenbeck Christian</td>
<td>O-1115-02</td>
</tr>
<tr>
<td>Roehrig Romain</td>
<td>P-3330-36</td>
</tr>
<tr>
<td>Roelfsema, Mark</td>
<td>O-4402b-01</td>
</tr>
<tr>
<td>Rogelj Joeri</td>
<td>K-L2.2-02, P-4402-12, P-1114-07</td>
</tr>
<tr>
<td>Roger Jean Claude</td>
<td>P-1105-07</td>
</tr>
<tr>
<td>Rogge Karoline</td>
<td>P-3315-10</td>
</tr>
<tr>
<td>Rogier Christophe</td>
<td>O-2226-03</td>
</tr>
<tr>
<td>Rohmer Jeremy</td>
<td>P-4418-19</td>
</tr>
<tr>
<td>Rohrer Mario</td>
<td>P-1117-23, P-4418-27, O-2211-02</td>
</tr>
<tr>
<td>Rojas Ana Maria</td>
<td>O-3335-02</td>
</tr>
<tr>
<td>Rolinski Susanne</td>
<td>P-2217-13, P-2219-13, P-2218-06, K-2223-02</td>
</tr>
<tr>
<td>Roman Cuesta Rosa Roman</td>
<td>K-2218-01</td>
</tr>
<tr>
<td>Romeo Chamani</td>
<td>P-3330-84</td>
</tr>
<tr>
<td>Romero Lankao Paty</td>
<td>P-4415-04, P-3311-12</td>
</tr>
<tr>
<td>Romero Ruiz Milton</td>
<td>P-2238-04</td>
</tr>
<tr>
<td>Romero, Dennis</td>
<td>P-1116-09</td>
</tr>
<tr>
<td>Rome Sandra</td>
<td>P-1113-15, P-1113-18</td>
</tr>
<tr>
<td>Roming Niklas</td>
<td>P-4406-06</td>
</tr>
<tr>
<td>Romshoo Shakil</td>
<td>P-2211-11</td>
</tr>
<tr>
<td>Ronchail Josyane</td>
<td>O-1119b-01, K-1119a-02, P-1119-16, O-3325b-02</td>
</tr>
<tr>
<td>Ronco Paolo</td>
<td>P-2204-13</td>
</tr>
<tr>
<td>Roque Paxis</td>
<td>P-3315-11</td>
</tr>
<tr>
<td>Rosa Manzo</td>
<td>P-4412-09</td>
</tr>
<tr>
<td>Rose Adhiambo Akombo</td>
<td>P-3301-06</td>
</tr>
<tr>
<td>Rosen Richard</td>
<td>P-4414-18</td>
</tr>
<tr>
<td>Rosenstock Todd</td>
<td>P-1115-03</td>
</tr>
<tr>
<td>Rosenzweig Cynthia</td>
<td>O-L3.3-01, P-2223-07, P-2223-18, K-2223-01, O-2223-02P-4415-08</td>
</tr>
<tr>
<td>Roseta–Palma Catarina</td>
<td>P-4409-22</td>
</tr>
<tr>
<td>Rosier, Suzanne</td>
<td>O-1118a-01</td>
</tr>
<tr>
<td>Rosset Robert</td>
<td>O-3318-02</td>
</tr>
<tr>
<td>Rossi Alexandra</td>
<td>K-2212b-03</td>
</tr>
<tr>
<td>Rossi Claudio</td>
<td>O-3337-04</td>
</tr>
<tr>
<td>Rossi Vivien</td>
<td>O-2215-04, P-3331-01</td>
</tr>
<tr>
<td>Rostek, Frauke</td>
<td>P-1101-06</td>
</tr>
<tr>
<td>Author Name</td>
<td>Index Code</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Runhaar Hens</td>
<td>P-3312-19, P-4407-04</td>
</tr>
<tr>
<td>Rupasinghe H</td>
<td>P-3305-14</td>
</tr>
<tr>
<td>Rupp David</td>
<td>P-4412-06</td>
</tr>
<tr>
<td>Russo, Simone</td>
<td>O-1113-02</td>
</tr>
<tr>
<td>Rusticucci Matilde</td>
<td>P-2212a-22, O-1113-10</td>
</tr>
<tr>
<td>Rutherford, Scott</td>
<td>O-1110-03</td>
</tr>
<tr>
<td>Rutishauser Ervan</td>
<td>K-2215-01</td>
</tr>
<tr>
<td>Rwanyiziri Gaspard</td>
<td>P-2228-014</td>
</tr>
<tr>
<td>Rwanyiziri Gaspard</td>
<td>P-3329-05</td>
</tr>
<tr>
<td>Rybarczyk Hervé</td>
<td>O-2207-03</td>
</tr>
<tr>
<td>Saad Christian</td>
<td>P-3330-66</td>
</tr>
<tr>
<td>Saavedra–Romero, Luz Arlette</td>
<td>P-1121-08</td>
</tr>
<tr>
<td>Sabatier P</td>
<td>K-1101-03</td>
</tr>
<tr>
<td>Sabiiti Geoffrey</td>
<td>P-3312-15</td>
</tr>
<tr>
<td>Sabiiti Geoffrey</td>
<td>P-2224-22</td>
</tr>
<tr>
<td>Sabinot, Catherine</td>
<td>P-1111-07, P-4418-05</td>
</tr>
<tr>
<td>Sabot Manon</td>
<td>P-1119-16</td>
</tr>
<tr>
<td>Sachs Jeff</td>
<td>K-2206-01</td>
</tr>
<tr>
<td>Sachs Jeffrey</td>
<td>K-4402b-02</td>
</tr>
<tr>
<td>Sadeghi Zadegan Sadegh</td>
<td>P-2213-04</td>
</tr>
<tr>
<td>Sadori Laura</td>
<td>O-2241-05</td>
</tr>
<tr>
<td>Sadovski Alexey</td>
<td>O-2245-05, P-1107-14</td>
</tr>
<tr>
<td>Saeed Abdul–Razak</td>
<td>P-2219-14</td>
</tr>
<tr>
<td>Safa, Henri</td>
<td>P-3302-02, P-3303-03</td>
</tr>
<tr>
<td>Sagar Ambuj</td>
<td>O-4413a-01, K-4409b-01</td>
</tr>
<tr>
<td>Saha Senjuti</td>
<td>P-2217-10</td>
</tr>
<tr>
<td>Saikawa, Eri</td>
<td>P-1114-11</td>
</tr>
<tr>
<td>Saikia Bhrigu Prasad</td>
<td>P-2215-11</td>
</tr>
<tr>
<td>Saint–Jean Sébastien</td>
<td>P-2224-07</td>
</tr>
<tr>
<td>Saint–Lu, Marion</td>
<td>P-1119-18</td>
</tr>
<tr>
<td>Saito, Carlos</td>
<td>P-2240-16</td>
</tr>
<tr>
<td>Saito Makoto</td>
<td>K-1115-01</td>
</tr>
</tbody>
</table>

**INDEX OF AUTHORS**

Runhaar Hens (P-3312-19, P-4407-04)
# INDEX OF AUTHORS

<table>
<thead>
<tr>
<th>Author Name</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sander, Klas</td>
<td>K-2218-02</td>
</tr>
<tr>
<td>Sander Bjoern Ole</td>
<td>P-3320-24</td>
</tr>
<tr>
<td>Sanderson Benjamin</td>
<td>P-2202-04</td>
</tr>
<tr>
<td>Sandoval Jose M</td>
<td>P-2230-02</td>
</tr>
<tr>
<td>Sané, Tidiane</td>
<td>P-3330-19</td>
</tr>
<tr>
<td>Sanfo Safietou</td>
<td>P-3330-38, P-2204-02</td>
</tr>
<tr>
<td>Sangwan Neelam Singh</td>
<td>P-2224-23</td>
</tr>
<tr>
<td>San Miguel, Jesus</td>
<td>O-2233-03</td>
</tr>
<tr>
<td>Sanner Christophe</td>
<td>O-2215-03</td>
</tr>
<tr>
<td>Sanogo Souleymane</td>
<td>P-1117-41</td>
</tr>
<tr>
<td>Santarelli Massimo</td>
<td>P-3302-07</td>
</tr>
<tr>
<td>Santini Monia</td>
<td>P-2204-13, P-3320-08, P-2217-23</td>
</tr>
<tr>
<td>Santini William</td>
<td>K-1119a-02</td>
</tr>
<tr>
<td>Santisirisomboon Jerasorn</td>
<td>P-1117-28</td>
</tr>
<tr>
<td>Santonja M.</td>
<td>O-3326-03</td>
</tr>
<tr>
<td>Santos, Guillermo</td>
<td>P-3312-18</td>
</tr>
<tr>
<td>Santos Alice Bosco</td>
<td>O-1119b-02</td>
</tr>
<tr>
<td>Santos E.</td>
<td>P-2212b-02</td>
</tr>
<tr>
<td>Santruckova, Hana</td>
<td>P-1116-14</td>
</tr>
<tr>
<td>Sarafanov, Artem</td>
<td>O-1110-04</td>
</tr>
<tr>
<td>Saravia Lopez De Castilla Miguel</td>
<td>O-2212b-01</td>
</tr>
<tr>
<td>Sampietro Jorge</td>
<td>K-2209-02</td>
</tr>
<tr>
<td>Saroar Md. Mustafa</td>
<td>P-2243-10</td>
</tr>
<tr>
<td>Sarr Alioune Badara</td>
<td>O-3330a-03</td>
</tr>
<tr>
<td>Sarr Mamadou Adama</td>
<td>P-1102-16</td>
</tr>
<tr>
<td>Sarbyul Estella Kim</td>
<td>P-1121-07</td>
</tr>
<tr>
<td>Sathi Vishwambhar Prasada</td>
<td>P-2217-27</td>
</tr>
<tr>
<td>Satoh Yusuke</td>
<td>P-2202-05</td>
</tr>
<tr>
<td>Saturnino Luz</td>
<td>P-3321-02</td>
</tr>
<tr>
<td>Sauerborn Rainer</td>
<td>O-2226-03, P-1117-06, P-3325-06, O-3321-07</td>
</tr>
<tr>
<td>Saunois Marielle</td>
<td>P-1114-02</td>
</tr>
<tr>
<td>Sauquet Eric</td>
<td>K-2212b-03</td>
</tr>
<tr>
<td>Samset Bjorn H.</td>
<td>O-1122-06, P-2205-06</td>
</tr>
<tr>
<td>Samuel K</td>
<td>P-1123-07</td>
</tr>
<tr>
<td>Sánchez-Arcilla Agustín</td>
<td>K-2243-01</td>
</tr>
<tr>
<td>Sanchez–Gomez Emilía</td>
<td>P-1102-13, P-3330-56</td>
</tr>
<tr>
<td>Sanchez–Lorenzo Arturo</td>
<td>P-1119-19, O-1117-04</td>
</tr>
<tr>
<td>Sanchez–Moral S</td>
<td>P-1115-01</td>
</tr>
<tr>
<td>Sanchez–Royo Beòguna</td>
<td>P-1123-15</td>
</tr>
<tr>
<td>Sanchez, Daniel</td>
<td>P-2218-07</td>
</tr>
<tr>
<td>Sanchez Patricia G</td>
<td>P-2217-30</td>
</tr>
<tr>
<td>Sakurai Gen</td>
<td>P-2204-17</td>
</tr>
<tr>
<td>Salack Seyni</td>
<td>P-3330-69</td>
</tr>
<tr>
<td>Salagnac, Jean–Luc</td>
<td>P-4415-02, P-4415-07</td>
</tr>
<tr>
<td>Salah Yasin</td>
<td>O-3329-04</td>
</tr>
<tr>
<td>Salameh Therese</td>
<td>P-1114-08</td>
</tr>
<tr>
<td>Salamony, Peter</td>
<td>O-2233-03</td>
</tr>
<tr>
<td>Salas Y Melia David</td>
<td>P-1107-15</td>
</tr>
<tr>
<td>Salas, Juan</td>
<td>P-1107-11</td>
</tr>
<tr>
<td>Salas, Pablo</td>
<td>O-4420b-01</td>
</tr>
<tr>
<td>Saldanha, A.</td>
<td>P-2212b-01</td>
</tr>
<tr>
<td>Salick Jan</td>
<td>K-2224-03</td>
</tr>
<tr>
<td>Sall, Moussa</td>
<td>P-3330-32</td>
</tr>
<tr>
<td>Sall Amadou</td>
<td>P-3330-70</td>
</tr>
<tr>
<td>Sallée Jean–Baptiste</td>
<td>P-1111-06</td>
</tr>
<tr>
<td>Salu Susannah</td>
<td>P-4406-03</td>
</tr>
<tr>
<td>Salomon, Claire</td>
<td>O-4418a-02</td>
</tr>
<tr>
<td>Salvatteci, Renato</td>
<td>P-1116-09</td>
</tr>
<tr>
<td>Salzmann Nadine</td>
<td>P-1117-23, P-4418-27, O-2211-02</td>
</tr>
<tr>
<td>Samadi Sarah</td>
<td>P-2208-01</td>
</tr>
<tr>
<td>Samanmali Matara Arachchi</td>
<td>P-2210-07</td>
</tr>
<tr>
<td>Sambou Djiby</td>
<td>P-3330-71</td>
</tr>
<tr>
<td>Sambou Soussou</td>
<td>P-3320-09</td>
</tr>
<tr>
<td>Samie René</td>
<td>K-2212b-03</td>
</tr>
<tr>
<td>Sample Alaric</td>
<td>K-2216-01</td>
</tr>
<tr>
<td>Samset Bjorn H.</td>
<td>O-1122-06, P-2205-06</td>
</tr>
<tr>
<td>Samuel K</td>
<td>P-1123-07</td>
</tr>
<tr>
<td>Sánchez–Arcilla Agustín</td>
<td>K-2243-01</td>
</tr>
<tr>
<td>Sanchez–Gomez Emilía</td>
<td>P-1102-13, P-3330-56</td>
</tr>
<tr>
<td>Sanchez–Lorenzo Arturo</td>
<td>P-1119-19, O-1117-04</td>
</tr>
<tr>
<td>Sanchez–Moral S</td>
<td>P-1115-01</td>
</tr>
<tr>
<td>Sanchez–Royo Beòguna</td>
<td>P-1123-15</td>
</tr>
<tr>
<td>Sanchez, Daniel</td>
<td>P-2218-07</td>
</tr>
<tr>
<td>Sanchez Patricia G</td>
<td>P-2217-30</td>
</tr>
</tbody>
</table>
Schindler, Anne (O-1113-06)
Schinko Thomas (O-3310-02)
Schipper Lisa (K-3312-02, O-2222-05)
Schleich, Joachim (P-3315-10)
Schleussner Carl-Friedrich (P-2236-12, O-3340-02, P-2203-03)
Schleyer Michael (P2209-08)
Schlosberg David (O-2241-02)
Schlund Michael (K-2219-03, P-2219-11)
Schmid, Eva (P-4402-02)
Schmid Erwin (P-2223-07)
Schmidt-Vogt Dietrich (P-1123-171)
Schmidt, Carsten (P-1108-08)
Schmidt, Martina (P-1115-15, P-1115-12)
Schmidt Sabine (P-1117-03)
Schmullius, Christiane (P-2235-01)
Schneeberger, Michael (P-3302-02)
Schneider Adam (O-2241-05)
Schneider Niklas (O-1117-01)
Schnell J (O-1122-06)
Schoenenberger Elena (P-3305-17)
Scholes Robert (P-2235-01)
Schönbein Johannes (O-1101-04)
Schor Tatiana (P-1119-16)
Schröter, Kai (P-3337-02)
Schröter, G. (P-2225-11)
Schucht, Simone (O-1121-02)
Schuck-Zöller Susanne (P-4418-28)
Schuetze, Franziska (K-4405-04)
Schuetz Tonya (O-4414-02)
Schultes, Anselm (K-3308-03, P-4406-06)
Schulz M (O-1122-06)
Schumacher Ingmar (P-2242-06, O-4408-03)
## INDEX OF AUTHORS

<table>
<thead>
<tr>
<th>Author Name</th>
<th>Category</th>
<th>Index Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schurgers, Guy</td>
<td>O</td>
<td>P-2217-25, P-1116-17</td>
</tr>
<tr>
<td>Schuur Edward</td>
<td>P</td>
<td>P-1116-14, O-1116-02, P-1116-01, K-1116-02</td>
</tr>
<tr>
<td>Schwab, Maria</td>
<td>K</td>
<td>K-1118b-01</td>
</tr>
<tr>
<td>Schwartzman Stephan</td>
<td>O</td>
<td>O-2238-04</td>
</tr>
<tr>
<td>Schwarze Reimund</td>
<td>O</td>
<td>O-4406b-04, O-2233-01, P-3313-08</td>
</tr>
<tr>
<td>Schwarz Jakob</td>
<td>P</td>
<td>P-1105-18</td>
</tr>
<tr>
<td>Schwarz Marc</td>
<td>P</td>
<td>P-1105-18</td>
</tr>
<tr>
<td>Schwerhoff Gregor</td>
<td>P</td>
<td>P-3308-01, P-4409-19, P-4406-06</td>
</tr>
<tr>
<td>Schwietzke Stefan</td>
<td>O</td>
<td>O-1114-04</td>
</tr>
<tr>
<td>Sciare J.</td>
<td>P</td>
<td>P-1105-03</td>
</tr>
<tr>
<td>Scipal Klaus</td>
<td>P</td>
<td>P-1105-09</td>
</tr>
<tr>
<td>Scobie Michelle</td>
<td>K</td>
<td>K-L4.2-01, P-4409-33</td>
</tr>
<tr>
<td>Scocciarrotto, Enrico</td>
<td>O</td>
<td>O-1113-06</td>
</tr>
<tr>
<td>Scollan Nigel</td>
<td>O</td>
<td>O-2223-01</td>
</tr>
<tr>
<td>Scotto D’apollonia Lionel</td>
<td>O</td>
<td>O-4419-04</td>
</tr>
<tr>
<td>Scott Vivian</td>
<td>P</td>
<td>P-3301-09</td>
</tr>
<tr>
<td>Searchinger Timothy</td>
<td>P</td>
<td>P-2223-08</td>
</tr>
<tr>
<td>Sebai Amal</td>
<td>P</td>
<td>P-3302-08</td>
</tr>
<tr>
<td>Sebesvari Zita</td>
<td>O</td>
<td>O-2220-01</td>
</tr>
<tr>
<td>Seck, Moussa</td>
<td>K</td>
<td>K-3330b-03</td>
</tr>
<tr>
<td>Sedlbauer, Klaus</td>
<td>O</td>
<td>O-2231-06</td>
</tr>
<tr>
<td>Séférian Roland</td>
<td>P</td>
<td>P-1102-17</td>
</tr>
<tr>
<td>Seggel Anika</td>
<td>O</td>
<td>O-3320-04</td>
</tr>
<tr>
<td>Seghier Josiane</td>
<td>P</td>
<td>P-3330-72, P-3330-52</td>
</tr>
<tr>
<td>Seguin Jean Jacques</td>
<td>P</td>
<td>P-2212a-20, P-1119-02, P-2212b-04</td>
</tr>
<tr>
<td>Ségues Luc</td>
<td>P</td>
<td>P-3330-65</td>
</tr>
<tr>
<td>Seidel Jochen</td>
<td>P</td>
<td>P-2211-12</td>
</tr>
<tr>
<td>Seidenkrantz Marit-Solveig</td>
<td>K</td>
<td>K-1103-01</td>
</tr>
<tr>
<td>Seidou Ousmane</td>
<td>P</td>
<td>P-3330-28, P-1102-16</td>
</tr>
<tr>
<td>Seidou Sandra, Ibrah</td>
<td>K</td>
<td>K-3330a-03, P-3330-66</td>
</tr>
<tr>
<td>Seifert Frank Martin</td>
<td>K</td>
<td>K-2215-03</td>
</tr>
<tr>
<td>Seiler Christian</td>
<td>O</td>
<td>O-2204-04</td>
</tr>
<tr>
<td>Seiler Roberto A</td>
<td>P</td>
<td>P-2239-11</td>
</tr>
<tr>
<td>Seixas Eunice</td>
<td>P</td>
<td>P-2243-11</td>
</tr>
<tr>
<td>Seixas Julia</td>
<td>P</td>
<td>P-2230-05</td>
</tr>
<tr>
<td>Seke Mvumbi Richard Dema</td>
<td>P</td>
<td>P-3305-15</td>
</tr>
<tr>
<td>Seland Øyvind</td>
<td>O</td>
<td>O-1116-01, O-1102-03</td>
</tr>
<tr>
<td>Sellegri K.</td>
<td>P</td>
<td>P-1105-03</td>
</tr>
<tr>
<td>Selvaraj, Kandasamy</td>
<td>K</td>
<td>K-1103-01</td>
</tr>
<tr>
<td>Semenova Inna</td>
<td>P</td>
<td>P-2204-09</td>
</tr>
<tr>
<td>Sempéré Richard</td>
<td>P</td>
<td>P-3326-02</td>
</tr>
<tr>
<td>Sena, E.</td>
<td>P</td>
<td>P-221501</td>
</tr>
<tr>
<td>Seneviratne Sonia</td>
<td>O</td>
<td>O-1114-05, O-1118a-03, K-L1.2-01</td>
</tr>
<tr>
<td>Sen Gupta, Alex</td>
<td>O</td>
<td>O-1110-01</td>
</tr>
<tr>
<td>Sengupta Pradip Kumar</td>
<td>K</td>
<td>K-4418a-02</td>
</tr>
<tr>
<td>Senina Inna</td>
<td>O</td>
<td>O-2209-01</td>
</tr>
<tr>
<td>Senn Josef</td>
<td>P</td>
<td>P-2214-05</td>
</tr>
<tr>
<td>Seo, M. C.</td>
<td>P</td>
<td>P-2223-04</td>
</tr>
<tr>
<td>Seoane José Carlos Sicoli</td>
<td>O</td>
<td>O-1119b-02</td>
</tr>
<tr>
<td>Seppelt, Ralf</td>
<td>K</td>
<td>K-2220-02</td>
</tr>
<tr>
<td>Sérazin Guillaume</td>
<td>O</td>
<td>O-1117-03</td>
</tr>
<tr>
<td>Sérémé Drissa</td>
<td>P</td>
<td>P-3320-06</td>
</tr>
<tr>
<td>Serquet, Gaëlle</td>
<td>P</td>
<td>P-1117-38</td>
</tr>
<tr>
<td>Serrano, R.</td>
<td>P</td>
<td>P-1119-19</td>
</tr>
<tr>
<td>Serrano Evelie</td>
<td>P</td>
<td>P-4407-05</td>
</tr>
<tr>
<td>Serra–Neumann Silvia</td>
<td>P</td>
<td>P-2236-16</td>
</tr>
<tr>
<td>Serre, Sandrine</td>
<td>O</td>
<td>O-3327-02</td>
</tr>
<tr>
<td>Serre Caroline</td>
<td>P</td>
<td>P-3317-05</td>
</tr>
<tr>
<td>Servain–Courant Sylvie</td>
<td>P</td>
<td>P-3312-09</td>
</tr>
<tr>
<td>Servain, Jacques</td>
<td>O</td>
<td>O-1106-01</td>
</tr>
<tr>
<td>Seto, Karen</td>
<td>O</td>
<td>O-3316-01</td>
</tr>
<tr>
<td>Sèze, Geneviève</td>
<td>P</td>
<td>P-2215-10</td>
</tr>
<tr>
<td>Sferra Fabio</td>
<td>O</td>
<td>O-4412-01</td>
</tr>
<tr>
<td>Sfetsos Athanasios</td>
<td>P</td>
<td>P-1113-04</td>
</tr>
</tbody>
</table>
INDEX OF AUTHORS

Sforna Giorgia (P-4409-08)
Shackleton Sheona (P-3328-18, K-3328-01)
Shafaq Masud (P-2240-20)
Shah, Santosh Kumar (P-1117-11, P-2214-02, P-1117-19)
Shahid Imran (P-1114-09)
Shahid Muhammad Zeeshaan (P-1121-13)
Shakhareh Yahya (P-3312-20)
Shaltout Mohamed (P-1107-16)
Shams Shahriar (P-3320-20)
Shannon Sarah (P-2204-10)
Shao Kwang-Tsao (P-1105-16)
Sharma, Bimal (P-2214-02)
Sharma Disha (P-1121-14)
Sharma K Rahul (P-3305-11)
Sharma Milap (P-1117-17)
Sharma Naushita (P-3303-20)
Sharma Prabha (O-2244-05)
Sharma Rajiv (K-4415a-03)
Sharmina, Maria (P-2236-02)
Shaver, Gaius (P-1116-14)
Sheble, Laura (P-4418-12)
Shekeladze Shalva (P-1115-13)
Shelestov Andrii (P-1105-08)
Sheng, Ruxv (P-3305-08)
Shen Suwan (O-3313-02)
Shepherd Andrew (K-1107-01)
Sheppard Stephen (P-3316-08)
Sherval Meg (P-3341-01)
Sherwood, Owen (O-1114-04)
Shigemitsu Masahito (P-2204-17)
Shikuku Kelvin (P-2225-12)
Shimada, Koji (O-2229-02)
Shimelis Hussein (P-3320-21)
Shindell D (O-1122-06)
Shinde Victor (P-3342-04)
Shinichiro Fujimori (K-2217-03)
Shiogama Hideo (O-1118b-04)
Shiori Sasaki (P-1104-01)
Shi Peijun (O-3324-03)
Shiraishi Norihiko (P-3325-03)
Shishlov Igor (P-4409-35, P-4409-34, P-4409-27)
Sholademi A (P-1117-43)
Sholademi Mutiat (P-1117-42, P-1117-43)
Shonhiwa Clement (O-3304-04)
Shrestha, Arbindra (P-2214-02)
Shukla Priyadarshi R (P-4406-02)
Shum Ck (O-1111b-03, O-1111b-02)
Shu Shijie (P-1116-10)
Siani, Giuseppe (O-1110-05)
Sicard Jean-Emmanuel (O-2211-05)
Sicard Pierre (P-3326-12)
Sicre Marie-Alexandrine (K-1103-01, O-2241-05)
Siddiquee Saeed Ahmed (P-3323-02)
Sié, Ali (P-1117-06)
Sié, Ali (O-3321-07)
Sié Ali (O-2226-03)
Siebert, Asher (P-3322-03, K-4412-01)
Siebert Rosemarie (P-3313-01)
Siegeier, Jan (P-4409-15, K-3308-03)
Siems Steven (P-1117-37)
Sietz Diana (P-3328-17)
Sife, Alfred (P-3328-10)
Sifeddine Abdelfettah (P-1119-03, O-1119b-02, P-1116-09)
Sigl Michael (O-1103-02, K-1103-02)
INDEX OF AUTHORS

Sigmoid, Michael (O-1108-01)
Sillmann J. (O-1113-02)
Silue Siele (P-1117-47)
Silva Moreira Luciane (P-1119-12, P-1119-17, O-1119b-02)
Silva, Diego (O-4418b-02)
Silva, Maria Consuelo (P-1117-29)
Silva Thyssia Bomfim De Araújo (P-2213-03)
Silvestri Silvia (O-3320-03)
Sima Adriana (P-1102-07)
Simao Andrea (P-2240-08)
Simelton Elisabeth (P-3320-22)
Simeoni Patricia (O-1111b-03)
Simioni, Guillaume (P-3326-04)
Simões Filho Francisco Fernando Lamego (O-1119b-02)
Simões Margareth (P-2214-06)
Simões Sofia (P-2230-05)
Simon David (P-4415-04)
Simonet Catherine (P-4401-02, P-3330-12)
Simonet Guillaume (P-4407-06, P-4407-07)
Sinabell Franz (O-2223-01, O-2203-03)
Sinan Mohamed (P-1113-07)
Sindico Francesco (K-4409b-03)
Singarayer Joy (P-2217-07)
Singh Ajay K (P-3342-04)
Singh Anil Kumar (P-2224-23)
Singh Chandni (O-2222-03, P-2222-10)
Singh Rambir (P-1123-07)
Singh Ranavijai Bahadur (P-3312-21)
Singhruck Patama (P-1117-28)
Singh Rupal (P-2224-23)
Singh Saudan (P-2224-23)
Singh Udayan (P-3303-20)

Sinha Bablu (P-1113-05)
Sinnhuber Bjoern-Martin (P-1108-07)
Siour Guillaume (O-2205-03)
Siqueira Jr. José Lázaro (P-2212a-18)
Siringan Fernando P (P-2217-30, P2209-05)
Siron Robert (P-3311-08)
Sist Plinio (K-2215-01, O-2215-01)
Sitati Asha (P-4418-29)
Sitch, Stephen (O-2217-02, P-1114-11)
Siti Nor Khuzaimah Amit (P-1104-01)
Sivankutty Rahul (P-1111-15)
Siwa Msangi (P-2223-10)
Six, Katharina (O-1116-01)
Six Delphine (O-2211-05)
Six Delphine (P-1105-17)
Skakun Sergii (P-1105-08)
Skea Jim (K-3315-01, P-3303-09)
Skeie Ragnhild Bieltvedt (O-1122-06, P-1114-10)
Skjellum Solrun Figenschau (K-3318-01)
Slingo Julia (P-2232-04)
Smeets, Roger (K-4413b-01)
Smiatek Gerhard (P-1104-04)
Smith, Octavio (P-3312-18)
Smith, Peggy (O-2238-03)
Smith, Vincent (O-2217-01)
Smith Andrew (P-2243-04)
Smith Benjamin (P-1116-17)
Smith Doug (P-1106-03)
Smit Herman (P-1105-19)
Smith Lydia (P-1116-15, P-2218-07)
Smith Pete (P-2218-02, K-3307-01 (part2))
Smith Richard (O-2238-04)
Smith Steve (O-3311-05)
Snoussi Maria (P-1113-07)
Snow Val (K-2223-02)
Soares De Araújo Francisca (O-2222-02)
Sobolowski Stefan (O-2205-03)
Sobral Portella João (P-2224-18)
Socolow Robert (P-3322-03, K-4412-01)
Soden Brian (K-1112-02)
Söderholm Patrik (P-3322-08)
Soffianian Alireza (P-2214-05)
Sochou Zacharie (P-1117-44)
Solano Ana (K-L3.5-03)
Solecki William (O-2203-02)
Soler Luciana Souza (P-3320-18)
Sólé Ola (P-4402-07)
Solidoro Cosimo (P2209-09, P-3320-23)
Solier Boris (O-4420b-05)
Solmon Fabien (O-1121-05)
Solomina Olga (P-1101-05)
Som De Cerff, Wim (P-4418-16)
Some Leopold (K-L3.5-06)
Sommer Michael (P-1105-02)
Somot Samuel (O-1117-04)
Sonder Kai (P-2224-09)
Song, Byeong-Gwon (P-1108-06)
Song, Hongzhi (P-1107-14)
Song, Yi (O-1122-03)
Sonwa Denis Jean (K-3311-01, P-3331-01)
Soo Hyun Lee (P-3321-08)
Sooraj N. P (P-4414-14)
Soria Arrasco Carla (O-2238-04)
Soterroni Aline (P-2214-14, O-2219-04, P-2219-02)
Soto, Doris (O-3320-04)
Sotta, Eleneide (P-2215-05)
Soubeyroux Jean-Michel (P-2212b-08, P-1104-09, O-1119b-04)
Souchon, Yves (P-2235-04)
Souhel Abdellatif (P-2212a-15)
Soura Bassiahia Abdramane (P-3330-22)
Sousa, Jose (P-1123-14)
Sousa Lisa (P-4409-22)
Soussana Jean-François (K-L2.5-01, P-2224-03, P-2224-04, K-2223-02)
Souvermezoglou Ekaterini (P-2207-03)
Souza Celena Regina Soeiro Moraes (O-3317-02)
Souza Ricardo C. M. (O-2219-04, P-2219-02)
Sovacool Benjamin (O-3303-03)
Spada Giorgio (P-3326-13)
Spain, Gerry (P-1115-12)
Spalding–Fecher Randall (O-4404-01)
Spandre Pierre (O-2211-04)
Sparrow Sarah (O-1118a-02, P-4412-07)
Spasova Zornitsa (P-2226-06)
Specht Alison (O-4418a-02)
Speich Sabrina (P-1110-03, P-1111-03, O-1110-02)
Spence, Paul (P-1107-06)
Sperling Daniel (O-3315-01)
Spiekermann, Raphael (O-2203-03)
Spires Meggan (P-3328-18)
Springmann Marco (O-3320-01)
Sprintall, Janet (O-1110-01)
Sprinz Detlef (P-4409-36)
Srairi Salim (P-1121-06)
St. George Scott (P-1117-19)
Stacke, Tobias (P-2205-11)
Staehle, Michael (P-4402-13)
Staehle, Michael (O-4402-13)
Stafford-Smith Mark (O-4415b-01)
Stainforth David Alan (P-3322-02, O-4418b-04, P-2236-07)
INDEX OF AUTHORS

17, O-4408-04)
Stakhiv Eugene Z. (P-4418-30)
Stanca Lucian (P-2223–17)
Standardi Gabriele (P-2242–07, O-3322b–03)
Stanley–Price, M. (O-4418b–01)
Stark Laura (P-2229–06)
Stead Rowena (O-3307–03)
Steckel Jan (P-4409–15, K-4406b–03)
Stefan Sobolowski (P-1117–08)
Steffensen Bernd (P-3317–06)
Steg Linda (O-3316–04)
Stehfest Elke (O-2217–02, K-2217–03, P-2217–08)
Steinaker, Diego (O-4418a–02)
Steinbacher Karoline (P-4402–11)
Steinberger Julia (P-4402–14)
Steiner Andrea K. (P-1105–09, P-1105–18)
Steininger Karl (O-3322b–02)
Stelzenmuller Vanessa (P-2236–11)
Stépanian Alexis (P-2239–01)
Stepanova Nadezda (P-2242–08)
Sterner Thomas (K-3308–01)
Stevanovic Miodrag (P-2217–13, P-2219–13, P-2218–06)
Stevenson Linda Anne (P-3342–05)
Stewart Bruce (K-2212a–02)
Still Gabriele (P-1108–02, O-1108–05)
Stock Charles (K-2209–02)
Stocker Benjamin D. (P-1116–16)
Stocker Sharon R. (O-2241–05)
Stocker Thomas (O-2245–01)
Stoffel Markus (P-4418–27)
Stone Dáithí (K-1118a–02)
Storch Daniela (O-2207–01)
Storkey Jonathan (O-1121–05)
Stott Peter (O-1118a–02, K-1118a–03)
Stouvenot Christian (O-2210–03)
Strand Gary (P-2202–04)
Streatfield Peter Kim (P-2212a–16)
Street Lorna (O-1116–02)
Strefler Jessica (O-3307–01 (part1))
Stringer Lindsay (P-4406–03)
Strobl Eric (P-2242–06)
Strosser Pierre (K-2212b–03)
Suarez Rodrigo (P-2230–02)
Suda, Michael (O-2216–01)
Sudre Joël (O-1115–04, O-1110–05)
Sueyoshi Tetsuo (P-2204–17)
Sugiyama Masa (P-3301–08)
Sukhishvili Lasha (P-2222–03)
Suladze Sulkhan (P-1115–13)
Sulla–Menashe Damien (O-1114–03)
Sultan Zakia (O-2233–02)
Sultan Benjamin (O-1119b–01, P-3330–73, P-3330–64, O-3325b–02, P-2217–28)
Sultan Benjamin (O-3330b–01)
Sumaila Rashid (K-2209–02, K-2209–04)
Summerton Philip (O-3335–01)
Sun, Yan (P-1117–45)
Sun De–Zheng (P-1117–45)
Sunderlin William (O-2219–01)
Sun Di (P-1117–12)
Sunny Atiquir Rahman (P-2243–12)
Sun Wenchao (P-2212b–13)
Suresh, I (K-1111a–02, K-L1.5–02)
Surminski Swenja (O-4408–01)
Susanna Mancinelli (O-3339–03)
Suškevičs Monika (P-2216–11)
Süsser Diana (P-2243-13)
Sutton Rowan (P-1118-03, O-1118b-01)
Suykens Cathy (P-3338-01)
Swail, V. R. (P-2207-05)
Swart Rob (P-4418-16)
Swati Katiyar (P-2205-07, P-1113-09)
Sweeney James (K-3305-01)
Swingedouw Didier (P-1102-17, K-L1.1-02)
Sy Abdoulaye (P-3330-74)
Syed Ahsan Ali Bokhari (P-2223-19)
Syed Munawar Husain Bukhary (P-3311-13)
Syktus Jozef (O-2205-01, P-2204-11)
Sylla Mouhamadou Bamba (P-1104-04, O-3330a-01, P-3330-75)
Sylvestre Florence (P-1101-06, K-1101-03)
Sy Souleymane (P-2217-28)
Szabo Peter (P-1118-07)
Szentimrey Tamás (P-1113-10)
Szewczyk, Wojtek (O-2237a-01)
Szopa, Sophie (O-1121-02)

T
T S Fousiya (P-1110-06)
Tabara David (P-2204-01)
Tabatabaei Muhamadreza (P-2201-02)
Tabau Anne-Sophie (P-4409-37)
Tabuchi Jean-Pierre (O-2229-05)
Tachiiri Kaoru (P-3307-01)
Tachikawa, Kazuyo (P-1101-06)
Taina De Luccas (P-2239-12)
Taisso Mackaye Hassan (O-3325b-03)
Takagi Hiroshi (K-1115-01)
Takahashi Ken (P-2211-06)
Takemura T (O-1122-06)
Tallec, Tiphaine (P-1115-06)
Tall Moustapha (P-3330-75)
Talukder Byomkesh (P-2225-19)
Tamburini Christian (P2209-06)
Taminiau Job (P-4415-09, P-2228-012)
Tanaka Katsumasa (P-2204-17, P-3307-07)
Tanaka Tsuneo (P-2207-03)
Tancredi Elda (P-4403-03)
Tangang Fredolin (P-1117-28)
Tang Xu (P-2233-06)
Tanimoun, Bachir (P-3330-33)
Tanner, Steve (O-1105b-05)
Tans, Pieter P. (O-1114-04)
Tantawi Samir (O-3304-01)
Tanyaniwa Vincent Itai (P-2240-21)
Tao, Zhang (P-3305-08)
Tapasco Jaimer (P-2217-12)
Taquet Marc (P-1111-13)
Tarabieh Khaled (P-1115-14)
Taranu Lilia (P-1102-18)
Tarchiani, Vieri (P-3330-19)
Tariq Salman (P-1121-15)
Tarli Vitor (P-2214-18)
Tarniewicz Jerome (P-1105-14)
Taryn Kong (O-4414-03)
Tavoni Massimo (P-2204-03, O-2237a-02, O-3307-02, K-4402b-01)
Taylor, M. (P-1108-08)
Taylor Andrea L (O-2240-02)
Taylor Richard (P-2212a-10)
Taylor Richard (O-2212-02)
Tay Sammy (P-3330-76, P-3330-76, P-3330-76)
Tchieudjo Christelle (P-2224-24)
INDEX OF AUTHORS

Tchung–Ming Stéphane (P-2236-15, P-4418–23)
Tebaldi Claudia (P-2204–12, P-2202–04)
Teh Tze Wei (P-1117–28)
Teichmann, Claas (O-3303–01)
Teklay Hailu, Amare (K-2219–02)
Telis Ioannis (K-3326–02)
Tellez–Arenas Agnes (P-4418–09)
Temper Leah (O-4417–06)
Tencer Barbara (O-1113–10)
Teng Fei (K-3333–02)
Teotia Manoj Kumar (P-2222–04)
Teresa Vaz (P-1105–11)
Terrat, Sebastien (P-1116–11)
Terray Laurent (O-L1.5–01, O-1117–03, O-1113–05, K-1117–02, O-1111a–02, P-1102–13)
Terzago Silvia (P-2211–10)
Testut Laurent (O-1111b–03, O-1111b–02)
Tett Simon (P-1118–02)
Teurlai Magali (P-4418–22, O-1111a–01)
Teweldemedhin Mogos (P-2223–20)
Thais, Françoise (O-3303–01, P-3303–03)
Thakur Barun Kumar (P-1123–170)
Thaler Thomas (P-3312–09)
Thao, Soulivan (O-1118b–03)
Thapa, Uday Kuwar (P-1117–11, P-2214–02)
Thaven Naidoo (O-3310–03)
The Caviars Team (P-3330–53)
Theeban Par (P-2224–25)
Thepaut Jean–Noel (O-2232–01)
Thi My Thi Tong (P-1123–16)
Thiaw Wassila (K-3330a–03, P-1117–46)
Thibaudon Michel (P-1121–09)
Thibaut Séverin (O-L1.5–01, O-1111a–02)

Thibon Christian (P-2228–014)
Thiéblemont Rémi (P-1108–04)
Thiel–Clemen Thomas (P-2235–01)
Thiel, Michael (P-2217–18, O-2244–02)
Thielen–Del Pozo Jutta (O-2233–03)
Thierion Charlotte (P-2212b–08)
Thierry De Ville D’avray Laure (P2209–10)
Thierry, Anne–Mathilde (O-3327–02)
Thierry Aaron (O-1116–02)
Thierry Pellarin (P-2212a–03)
Thierry Virginie (O-1110–04)
Thiery Dominique (P-2212b–08)
Thies H (P-1101–04)
Thil, François (O-1102–09)
Thirel Guillaume (K-2212b–03)
Thirumalai, Kaustubh (K-1103–01)
Tholen, Lena (P-3305–16)
Thomas Aled (K-3314–01)
Thomas, Dogot (P-4414–22, P-2222–13)
Thomas, Tony (O-1113–03)
Thomas Hale (O-4410–01)
Thomas Sebastian (P-1114–13)
Thomas Shaji (P-2212b–01, P-2240–22)
Thomas Stefan (P-3305–16)
Thomas Timothy S. (P-3330–47, P-2219–08)
Thompson Andrew (K-1111b–01, K-L1.5–04)
Thompson Olaniran (P-2205–08)
Thomsen Laurent (K-2208–03)
Thomson Madeleine (P-1104–10, P-4418–06, K–4418b–01)
Thonicke, Kirsten (O-2244–01)
Thorncroft Chris (P-3330–77)
Torne, Peter (P-1105–02)
INDEX OF AUTHORS

International Scientific Conference
7-10 JULY 2015
PARIS, FRANCE

Thornton P.t. (O-2235-03, O-4414-02, O-2236-02)
Thoron Sylvie (O-3326-04)
Thoto Frejus (P-2243-14)
Thouret Valerie (P-1105-19)
Thouveny, Nicolas (P-1101-06)
Thuillier Thomas (P-1123-175)
Thysse, Peter (P-4418-16)
Tian Hanqin (P-1114-11)
Tiani Anne Marie (O-3331-03)
Tian Lide (O-1102-06)
Tickamyer Ann (P-3341-11)
Tidjani Adamou Didier (P-3330-01)
Tiendrébéogo Fidèle (P-3320-06)
Tiffin Richard (O-2223-01)
Tiina–Riitta Lappi (P-2229-06)
Tim Duffy (P-1105-12)
Timera Mamadou Bouna (P-3313-05)
Timileina, Rupraj (P-1117-11)
Timmreck Claudia (O-1103-05)
Timoléon Andzi Barhe (P-1121-16)
Timouk Frank (K-1119a-02)
Tim Payn (K-L3.5-05)
Tindimugaya Callist (P-3330-80)
Tironi-Silva Antonio (P-3322-09)
Titaud Olivier (O-2209-01)
Tito De Morais Luis (P2209-03)
Tiwari Abhinav (P-2210-08, P-3315-12)
Tiwari Prakash Chandra (O-3313-01)
Tixier Marie–Stéphane (P-2225-13)
Tjallingii Rik (P-3329-04)
Tjiputra Jerry (O-1116-01)
Tjoe Yenny (P-3332-03)
Tobin, Isabelle (P-3303-11, O-3303-01, P-2205-09)
Todadze Mariam (P-2212a-06, O-3336-01)
Togtokh Chuluun (K-2224-01, K-2224-02)
Tokarska Katarzyna (P-1107-18)
Toko Ismael (P-2224-17)
Toledo Marisol (O-2244-01)
Tollenaere Charlotte (P-3320-06)
Tomasella Javier (P-2212a-18)
Tomé Margarida (K-L3.5-05)
Tompkins, Adrian (O-3330b-03)
Tonga, Peguy (P-2214-14, P-2215-07)
Tonidandel David (P-1101-04)
Tonolli Alejandro (P-2239-11)
Toohey, Matthew (O-1103-05, O-1103-02, K-1103-02)
Toreti Andrea (O-1113-06, P-1113-23)
Torn Margaret S (P-1116-15, P-4402-15, O-1115-06, P-2218-07)
Torresan Silvia (P-2204-13, P-4418-11)
Torvanger Asbjørn (K-4404-01)
Toshichika Iizumi (P-2204-17)
Totin Vodounon Sourou Henri (O-1119b-05, P-3331-04)
Toulmin Camilla (O-2235-07)
Touré N’datchoh Evelyn (P-1117-47)
Tourre Yves (O-2226-03)
Touzard Jean–Marc (P-2224-21, P-2224-04)
Tra Bi Zamblé Armand (O-1119a-01)
Trabucco Antonio (P-2204-13)
Tramblay Yves (O-1119b-05)
Tramblay Yves (P-2211-04, P-1102-16)
Tran A (P-1121-05)
Trancik Jessika (P-1114-12)
Traore Chazalnoel Mariam (O-3325a-02)
Traoré Edgar (P-3320-06)
Traoré Issouf (O-3321-07)
## INDEX OF AUTHORS

<table>
<thead>
<tr>
<th>Author Name</th>
<th>ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traoré Oumar</td>
<td>(P-3320-06)</td>
</tr>
<tr>
<td>Traoré Vieux Boukhali</td>
<td>(P-3320-09)</td>
</tr>
<tr>
<td>Trap Jean</td>
<td>(P-3325-02)</td>
</tr>
<tr>
<td>Trauernicht C</td>
<td>(P-2201-03)</td>
</tr>
<tr>
<td>Traut Michael</td>
<td>(P-4403-01)</td>
</tr>
<tr>
<td>Treat, Claire</td>
<td>(P-1116-14)</td>
</tr>
<tr>
<td>Treguer Anne Marie</td>
<td>(P-1106-04)</td>
</tr>
<tr>
<td>Triantaphyllou Maria</td>
<td>(P-3326-05, O-2241-05)</td>
</tr>
<tr>
<td>Tribollet Aline</td>
<td>(O-2207-03)</td>
</tr>
<tr>
<td>Trigo Ricardo</td>
<td>(O-2245-02, O-1102-08, K-3326-01)</td>
</tr>
<tr>
<td>Trinh-Tuan Long</td>
<td>(P-1117-28)</td>
</tr>
<tr>
<td>Trinh, Thai</td>
<td>(P-1108-06)</td>
</tr>
<tr>
<td>Tripathi, Om</td>
<td>(O-1108-01)</td>
</tr>
<tr>
<td>Triraganon, Ronnakorn</td>
<td>(O-2220-02)</td>
</tr>
<tr>
<td>Troeltzsch, Jenny</td>
<td>(K-3309-01)</td>
</tr>
<tr>
<td>Trollip Hilton</td>
<td>(P-4402-16, O-4411-01)</td>
</tr>
<tr>
<td>Trotignon Raphael</td>
<td>(O-4420b-05)</td>
</tr>
<tr>
<td>Troussier Tiané</td>
<td>(O-1101-03)</td>
</tr>
<tr>
<td>Trutnevye Evelina</td>
<td>(O-2236-04)</td>
</tr>
<tr>
<td>Tsagaraki Tatiana</td>
<td>(P-2207-03)</td>
</tr>
<tr>
<td>Tsalefac, Maurice</td>
<td>(P-3330-26)</td>
</tr>
<tr>
<td>Tsanis Ioannis</td>
<td>(O-2205-04, P-2204-14, O-2201-03)</td>
</tr>
<tr>
<td>Tsapakis Manolis</td>
<td>(P-2207-03)</td>
</tr>
<tr>
<td>Tseelei Enkh-Amgalan</td>
<td>(P-4414-20)</td>
</tr>
<tr>
<td>Tseng Hsiao-Chun</td>
<td>(P-1110-07)</td>
</tr>
<tr>
<td>Tshindane Mpfunzeni</td>
<td>(P-2220-02)</td>
</tr>
<tr>
<td>Tsilo Toi</td>
<td>(P-3320-21)</td>
</tr>
<tr>
<td>Tsiola Anastasia</td>
<td>(P-2207-03)</td>
</tr>
<tr>
<td>Tsoi Cherry</td>
<td>(P-1123-12)</td>
</tr>
<tr>
<td>Tsuji, Leonard</td>
<td>(P-3320-04)</td>
</tr>
<tr>
<td>Tsuyoshi Fujita</td>
<td>(P-4414-12)</td>
</tr>
<tr>
<td>Tsyro S</td>
<td>(O-1122-06)</td>
</tr>
<tr>
<td>Tucker Catherine</td>
<td>(K-L3.5-03, O-2211-01, K-2211-01)</td>
</tr>
<tr>
<td>Tudela Fernando</td>
<td>(P-2234-02)</td>
</tr>
<tr>
<td>Tufail Jarul</td>
<td>(P-1117-48)</td>
</tr>
<tr>
<td>Tukker Arnold</td>
<td>(O-3317-04)</td>
</tr>
<tr>
<td>Tulet P.</td>
<td>(P-1105-03)</td>
</tr>
<tr>
<td>Tullus Arvo</td>
<td>(P-2216-11)</td>
</tr>
<tr>
<td>Tullus Hardi</td>
<td>(P-2216-11)</td>
</tr>
<tr>
<td>Tumbo Madaka</td>
<td>(P-2212b-14)</td>
</tr>
<tr>
<td>Turcq Bruno</td>
<td>(P-1119-12, P-1119-17, P-1119-03, O-1119b-02, P-1119-18)</td>
</tr>
<tr>
<td>Turhan Ethemcan</td>
<td>(P-4410-07, O-3311-04)</td>
</tr>
<tr>
<td>Turkes Murat</td>
<td>(P-1123-177)</td>
</tr>
<tr>
<td>Turki Imen</td>
<td>(P-2212a-14)</td>
</tr>
<tr>
<td>Turley Carol</td>
<td>(O-2207-05)</td>
</tr>
<tr>
<td>Turney, Chris</td>
<td>(P-1107-06)</td>
</tr>
<tr>
<td>Turp Mustafa Tufan</td>
<td>(P-1123-177)</td>
</tr>
<tr>
<td>Turton Steve</td>
<td>(O-2201-04)</td>
</tr>
<tr>
<td>Tu Su–Hao</td>
<td>(O-3321-11)</td>
</tr>
<tr>
<td>Tutwiler Rick</td>
<td>(P-1115-14)</td>
</tr>
<tr>
<td>Tuyara Gavrillieva</td>
<td>(P-2242-08)</td>
</tr>
<tr>
<td>Twine, Wayne</td>
<td>(P-2235-01)</td>
</tr>
<tr>
<td>Tyler, Stephen</td>
<td>(P-2212b-11)</td>
</tr>
<tr>
<td>Tyler Emily</td>
<td>(P-4406-09)</td>
</tr>
<tr>
<td>Tymofeyev Vladyslav</td>
<td>(P-1117-49)</td>
</tr>
<tr>
<td>Uchino, Osamu</td>
<td>(K-1115-01)</td>
</tr>
<tr>
<td>Uddin Md. Rafi</td>
<td>(P-1113-20)</td>
</tr>
<tr>
<td>Uddin Saleh</td>
<td>(P-4407-08)</td>
</tr>
<tr>
<td>Udrea Lavinia Ioana</td>
<td>(P-1123-09)</td>
</tr>
<tr>
<td>Uhe, Peter</td>
<td>(P-2240-17)</td>
</tr>
<tr>
<td>Uittenbroek, C.</td>
<td>(P-3312-19)</td>
</tr>
<tr>
<td>Uitz Julia</td>
<td>(P-1111-03)</td>
</tr>
<tr>
<td>Ultré-Guérard Pascale</td>
<td>(K-1105a-01)</td>
</tr>
<tr>
<td>Underdal, Arild</td>
<td>(P-4409-36)</td>
</tr>
</tbody>
</table>
INDEX OF AUTHORS

Van Eupen Michiel (O-2244-01)
Van Groenigen Kees Jan (P-1116-13)
Van Kerkhoff Lorrae (O-3325a-01, O-2214-01)
Van Leeuwen Cornelis (P-2224-21)
Van Looy Kris (P-2235-04)
Van Oldenborgh Geert Jan (O-1118a-02, O-1104-05)
Van Schijndel A.w.m. (P-2231-01, O-2231-10)
Van Soest Heleen (O-4402b-01)
Van Staden Maryke (O-4415b-03)
Van Vliet Michelle (P-2205-09)
Van Vuuren Detlef (O-2237a-02, O-3307-02, O-2217-02, K-4402b-01, P-2217-08, K-2217-01, K-2206-04)
Van Zonneveld Maarten (P-2224-26)
Van Aalst (O-1104-05, K-2233-O1)
Van Breevoort Pieter (O-4412-01)
Van Den Hurk Bart (P-2201-04)
Van Der Leeuw Sander (K-4405-03)
Van Der Meulen Suzanne (O-2220-01)
Van Der Voet Ester (O-3317-04)
Van Der Zwaan Bob (K-3335-02, K-3335-01, O-3335-03)
Van Dingenen Rita (O-3322b-06)
Van Doorens Tom (P-3312-22)
Van Doorslaer Benjamin (P-2223-17)

Van Eupen Michiel (O-2244-01)
Van Groenigen Kees Jan (P-1116-13)
Van Kerkhoff Lorrae (O-3325a-01, O-2214-01)
Van Leeuwen Cornelis (P-2224-21)
Van Looy Kris (P-2235-04)
Van Oldenborgh Geert Jan (O-1118a-02, O-1104-05)
Van Schijndel A.w.m. (P-2231-01, O-2231-10)
Van Soest Heleen (O-4402b-01)
Van Staden Maryke (O-4415b-03)
Van Vliet Michelle (P-2205-09)
Van Vuuren Detlef (O-2237a-02, O-3307-02, O-2217-02, K-4402b-01, P-2217-08, K-2217-01, K-2206-04)
Van Zonneveld Maarten (P-2224-26)
Van Aalst (O-1104-05, K-2233-O1)
Van Breevoort Pieter (O-4412-01)
Van Den Hurk Bart (P-2201-04)
Van Der Leeuw Sander (K-4405-03)
Van Der Meulen Suzanne (O-2220-01)
Van Der Voet Ester (O-3317-04)
Van Der Zwaan Bob (K-3335-02, K-3335-01, O-3335-03)
Van Dingenen Rita (O-3322b-06)
Van Doorens Tom (P-3312-22)
Van Doorslaer Benjamin (P-2223-17)
<table>
<thead>
<tr>
<th>Author</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Varghese Nisha</td>
<td>P-2217-29</td>
</tr>
<tr>
<td>Varma, Vidja Dr.</td>
<td>O-1102-03</td>
</tr>
<tr>
<td>Vasquez Campos Edwin</td>
<td>O-2238-04</td>
</tr>
<tr>
<td>Vaughan Naomi</td>
<td>P-3301-09, P-3307-09</td>
</tr>
<tr>
<td>Vautard Robert</td>
<td>P-3303-11, O-1118a-02, O-2202-03, O-2205-03, P-1104-09, P-1118-04, P-2205-09, O-1121-02, O-1121-05, O-2232-04, O-3303-01</td>
</tr>
<tr>
<td>Vaz Lucelia</td>
<td>P-2233-01</td>
</tr>
<tr>
<td>Vazquez, Eusebi</td>
<td>P-2217-21, P-1115-02, P-1116-08, P-1123-02</td>
</tr>
<tr>
<td>Veeger Marieke</td>
<td>O-2236-02</td>
</tr>
<tr>
<td>Véga, Cédric</td>
<td>P-2215-08</td>
</tr>
<tr>
<td>Veizaga Alfredo</td>
<td>P-2212b-12</td>
</tr>
<tr>
<td>Velasco Marc</td>
<td>P-2234-03</td>
</tr>
<tr>
<td>Velikin Sergey</td>
<td>P-2205-04</td>
</tr>
<tr>
<td>Vellico Michela</td>
<td>O-3307-03</td>
</tr>
<tr>
<td>Venkatachalam, L</td>
<td>P-2243-02</td>
</tr>
<tr>
<td>Venturini Tommaso</td>
<td>P-4418-31, P-2236-06</td>
</tr>
<tr>
<td>Vera Carolina</td>
<td>P-1102-19</td>
</tr>
<tr>
<td>Verbeeck Hans</td>
<td>O-2204-04</td>
</tr>
<tr>
<td>Verboom Jana</td>
<td>P-2214-13, O-2244-01</td>
</tr>
<tr>
<td>Verbruggen, Cyriel</td>
<td>O-1110-05</td>
</tr>
<tr>
<td>Verburg Peter</td>
<td>O-2218-02</td>
</tr>
<tr>
<td>Vechot Louis</td>
<td>K-2218-01, O-2219-06, P-2219-05, O-1117-02, K-3311-01</td>
</tr>
<tr>
<td>Verdier Jean</td>
<td>O-2212b-03</td>
</tr>
<tr>
<td>Verdolini Elena</td>
<td>O-4413b-02, P-3315-13, P-3303-21</td>
</tr>
<tr>
<td>Verfaillie Deborahah</td>
<td>O-2211-04</td>
</tr>
<tr>
<td>Vergara Oscar</td>
<td>O-1110-05</td>
</tr>
<tr>
<td>Vergnes Jean-Pierre</td>
<td>P-2212b-08</td>
</tr>
<tr>
<td>Verma Shreeya</td>
<td>O-1115-02</td>
</tr>
<tr>
<td>Vermaßen Hannah</td>
<td>O-4417-01</td>
</tr>
<tr>
<td>Vermeulen, Alex</td>
<td>O-1115-01</td>
</tr>
<tr>
<td>Verneaux V</td>
<td>K-1101-03</td>
</tr>
<tr>
<td>Vernoux Jean Francois</td>
<td>P-2212a-20</td>
</tr>
<tr>
<td>Verola Christiano Franco</td>
<td>P-2215-06</td>
</tr>
<tr>
<td>Verschuren Dirk</td>
<td>P-3329-04</td>
</tr>
<tr>
<td>Vervoort Joost</td>
<td>O-2236-02</td>
</tr>
<tr>
<td>Verweij Peter</td>
<td>P-2214-06</td>
</tr>
<tr>
<td>Vestreng Vigdis</td>
<td>K-3318-01</td>
</tr>
<tr>
<td>Veton Gilles</td>
<td>P-2208-03</td>
</tr>
<tr>
<td>Vetter, Sylvia</td>
<td>P-2218-03</td>
</tr>
<tr>
<td>Vettorazzi, Carlos</td>
<td>P-2214-15</td>
</tr>
<tr>
<td>Vialard Jérôme</td>
<td>K-1111a-02, K-L1.5-02</td>
</tr>
<tr>
<td>Vianco, Ana</td>
<td>P-2239-11</td>
</tr>
<tr>
<td>Vianny Natugonza</td>
<td>P-3341-07</td>
</tr>
<tr>
<td>Vicarelli Marta</td>
<td>P-2234-04</td>
</tr>
<tr>
<td>Vicente–Serrano Sergio M.</td>
<td>P-1119-19, O-1102-08</td>
</tr>
<tr>
<td>Vicente May Celine Thelma</td>
<td>P-2217-30</td>
</tr>
<tr>
<td>Vichi, Marcello</td>
<td>P2209-09</td>
</tr>
<tr>
<td>Victor D.</td>
<td>K-L4.4-01</td>
</tr>
<tr>
<td>Vicuna Sebastian</td>
<td>P-3312-14</td>
</tr>
<tr>
<td>Vidal, Céline</td>
<td>O-1103-03</td>
</tr>
<tr>
<td>Vidal Jean–Philippe</td>
<td>K-2212b-03, O-1119b-04</td>
</tr>
<tr>
<td>Viel Christian</td>
<td>O-2226-03</td>
</tr>
<tr>
<td>Viennot Pascal</td>
<td>P-2212b-08</td>
</tr>
<tr>
<td>Vigaud Nicolas</td>
<td>O-1113-04</td>
</tr>
<tr>
<td>Vigil Sara</td>
<td>O-4410-03</td>
</tr>
<tr>
<td>Vigil Sara</td>
<td>O-2242-07</td>
</tr>
<tr>
<td>Vignaroli, Patrizio</td>
<td>P-3330-19</td>
</tr>
<tr>
<td>Vignati Elisabetta</td>
<td>O-3304-02</td>
</tr>
<tr>
<td>Vignolles Cécile</td>
<td>O-2226-03, O-3321-07</td>
</tr>
<tr>
<td>Viguie Vincent</td>
<td>P-4415-07</td>
</tr>
<tr>
<td>Vilacleta, Gloria</td>
<td>P-2212a-19</td>
</tr>
</tbody>
</table>
INDEX OF AUTHORS

International Scientific Conference       7-10 JULY 2015       PARIS, FRANCE

Vilcabana, S. (P-1119-13)
Villamor Grace (P-3330-06, P-3330-50)
Villanoy, Cesar (P2209-07, P-1119-05)
Villarroel Elena (P-2238-07)
Villegas Ivich Carlos (P-4417-04)
Villholth Karen (P-3320-02)
Vimeux F. (P-1105-03)
Vimont Daniel (O-1117-01)
Vincent Cери (O-3307-03)
Vincent Christian (P-1105-17)
Vincec Eniko (P-1113-10, P-2220-03)
Vinogradova Vera (P-2211-13)
Viñuales Jorge (O-2237b-02)
Viollet Pierre-Louis (O-2212b-03)
Viovy Nicolas (O-1121-05)
Vira B. (K-L3.4-03)
Virto Iñigo (P-1116-05, K-1116-03)
Visbeck Martin (K-1110-01)
Vischel Théo (P-3330-78, P-3330-33)
Vision, Todd (P-4418-12, O-4418a-02)
Vitart, Frederic (O-1108-01)
Vitasse, Yann (P-1117-38)
Vitoux Marie-Claire (O-1101-04)
Vivarelli Arianna (P-3305-17)
Vivin Philippe (P-2224-21)
Vlachogianni Mandi (P-1113-04)
Vodouhe Sognon Raymond (P-3312-11)
Vodounou Jean Bosco (P-3330-79)
Voeller, Sonja (P-3316-01)
Vogel Coleen (K-4414-01, O-4414-03)
Vogel Elisabeth (P-4418-29)
Vogel Elisabeth (P-2234-05)
Vogl Adrian L. (K-4418a-01)
Vogt-Schilb Adrien (K-2234-03)
Vogt, Juergen (O-2233-03)
Vogt, N. (P-2212b-01)
Voigt Christina (O-2219-07)
Voldoire Aurore (O-1122-01)
Volz-Thomas Andreas (P-1105-19)
Von Hardenberg Jost (P-2211-10)
Von Poncet Felicitas (K-2219-03, O-2219-02, P-2219-11)
Von Randow Celso (P-2236-08, O-2204-04, O-2244-01)
Von Schwerin Sheryn Marie (P-2243-15)
Von Stechow Christoph (P-4402-17)
Von Vraun Joachim (P-2204-02)
Vona Francesco (P-3303-21)
Von Randow Rita De Cassia S. (P-2212a-18)
Von Storch, Hans (K-1118b-01)
Vos Claire (P-2214-13)
Vouillamo Jean-Michel (P-3330-80)
Voukouvalas Evangelos (P-2204-14)
Vousdoukas Michalis (P-2204-14)
Vrontisi Zoi (O-4402a-02, P-3303-22)
Vucetic Marko (P-2216-12)
Vucetic Visnjica (P-2223-21)
Vuille Mathias (P-1119-03)
Vuillemin, Cyrille (O-2212b-03)
Vylidal Tomas (P-2231-01)
W
W. Klinthong (P-2243-16)
W. Samsuvan (P-2243-16)
W. Suebpala (P-2243-16)
Wabwire Evans (P-3312-23)
Wadai, Yoshihide (P-2205-11)
Wada Kenichi (P-3315-14)
Wade, Malick (P-2217-28, P-3330-13)
## INDEX OF AUTHORS

<table>
<thead>
<tr>
<th>Author Name</th>
<th>Reference Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wadhams Peter</td>
<td>(O–3327–03)</td>
</tr>
<tr>
<td>Waelbroeck Claire</td>
<td>(O–1102–09, O–1110–05)</td>
</tr>
<tr>
<td>Wagner Fabien</td>
<td>(O–2215–04)</td>
</tr>
<tr>
<td>Wagner Gernot</td>
<td>(O–3322b–02)</td>
</tr>
<tr>
<td>Wagner Sebastian</td>
<td>(K–3326–02)</td>
</tr>
<tr>
<td>Wagnon Patrick</td>
<td>(P–1105–17)</td>
</tr>
<tr>
<td>Wahbi Said</td>
<td>(P–2225–02)</td>
</tr>
<tr>
<td>Wahner Andreas</td>
<td>(P–1105–19)</td>
</tr>
<tr>
<td>Wainer, Ilana</td>
<td>(P–1102–14)</td>
</tr>
<tr>
<td>Wairiu Morgan</td>
<td>(P–2224–10, P–3320–14)</td>
</tr>
<tr>
<td>Waisman Henri</td>
<td>(K–4402b–02)</td>
</tr>
<tr>
<td>Walkers Romain</td>
<td>(P–2210–09)</td>
</tr>
<tr>
<td>Waldhoff, Stephanie</td>
<td>(O–3320–02, P–3340–01)</td>
</tr>
<tr>
<td>Waldmann, Nicolas</td>
<td>(P–1101–06)</td>
</tr>
<tr>
<td>Waldrop, Mark</td>
<td>(P–1116–14)</td>
</tr>
<tr>
<td>Wale, Edilegnaw</td>
<td>(O–2240–03)</td>
</tr>
<tr>
<td>Walker Anthony</td>
<td>(P–2215–04)</td>
</tr>
<tr>
<td>Walker Catherine</td>
<td>(P–1107–17)</td>
</tr>
<tr>
<td>Walker Gordon</td>
<td>(K–3317–01)</td>
</tr>
<tr>
<td>Walker Wayne</td>
<td>(O–1114–03, O–2238–04)</td>
</tr>
<tr>
<td>Wallom David</td>
<td>(O–1118a–02)</td>
</tr>
<tr>
<td>Walmsley Nigel</td>
<td>(O–4401–05)</td>
</tr>
<tr>
<td>Walnum Hans Jakob</td>
<td>(P–3305–18)</td>
</tr>
<tr>
<td>Walser C.</td>
<td>(P–1101–04)</td>
</tr>
<tr>
<td>Walter Leal Filho</td>
<td>(P–4409–01)</td>
</tr>
<tr>
<td>Walther Régis</td>
<td>(P–2210–06)</td>
</tr>
<tr>
<td>Walz Henriette</td>
<td>(O–3339–04)</td>
</tr>
<tr>
<td>Wamari Joab</td>
<td>(P–1104–11)</td>
</tr>
<tr>
<td>Wamba André Le Doux</td>
<td>(P–2212a–21)</td>
</tr>
<tr>
<td>Wamuongo, Jane</td>
<td>(K–3312–01)</td>
</tr>
<tr>
<td>Wang, Da-Wei</td>
<td>(P–3321–11)</td>
</tr>
<tr>
<td>Wang, Fan</td>
<td>(O–1110–01)</td>
</tr>
<tr>
<td>Wang, Guojian</td>
<td>(O–1110–01)</td>
</tr>
<tr>
<td>Wang, Jun</td>
<td>(O–1116–03)</td>
</tr>
<tr>
<td>Wang, Qingye</td>
<td>(O–1110–01)</td>
</tr>
<tr>
<td>Wang, Wen-Cheng</td>
<td>(P–3321–11)</td>
</tr>
<tr>
<td>Wang, Xiaoxi</td>
<td>(P–2218–06)</td>
</tr>
<tr>
<td>Wang Charlotte</td>
<td>(P–3322–04)</td>
</tr>
<tr>
<td>Wang Jinxia</td>
<td>(O–3309–02)</td>
</tr>
<tr>
<td>Wang Juanle</td>
<td>(P–1105–20)</td>
</tr>
<tr>
<td>Wang Ninglian</td>
<td>(O–1102–06)</td>
</tr>
<tr>
<td>Wang Xiaolan</td>
<td>(P–2207–05)</td>
</tr>
<tr>
<td>Wang Xuhui</td>
<td>(P–2204–14)</td>
</tr>
<tr>
<td>Wanner Heinz</td>
<td>(P–1101–05)</td>
</tr>
<tr>
<td>Ward Adrian</td>
<td>(P–1114–13)</td>
</tr>
<tr>
<td>Wardell Andrew</td>
<td>(O–3323–03, O–3323–02)</td>
</tr>
<tr>
<td>Wardhono Endarto</td>
<td>(P–3305–19)</td>
</tr>
<tr>
<td>Warner Koko</td>
<td>(P–3321–17)</td>
</tr>
<tr>
<td>Warren Rachel</td>
<td>(P–2223–06)</td>
</tr>
<tr>
<td>Warszawski Lila</td>
<td>(P–2205–11)</td>
</tr>
<tr>
<td>Washida Toyoaki</td>
<td>(P–4402–10)</td>
</tr>
<tr>
<td>Waskow (K–L4.5–02)</td>
<td></td>
</tr>
<tr>
<td>Wassmann Reiner</td>
<td>(P–3320–24)</td>
</tr>
<tr>
<td>Wassmer Patrick</td>
<td>(O–1101–04)</td>
</tr>
<tr>
<td>Watanabe Masahiro</td>
<td>(O–1118b–04)</td>
</tr>
<tr>
<td>Watanabe Masataka</td>
<td>(K–2224–02)</td>
</tr>
<tr>
<td>Watanabe Satoko</td>
<td>(K–2224–02)</td>
</tr>
<tr>
<td>Watanabe Takashi</td>
<td>(P–1105–21)</td>
</tr>
<tr>
<td>Watkins, Nicholas</td>
<td>(O–4418b–04)</td>
</tr>
<tr>
<td>Watkiss Paul</td>
<td>(K–3309–01, O–3322b–02)</td>
</tr>
<tr>
<td>Watson, Andrew</td>
<td>(O–1115–01)</td>
</tr>
<tr>
<td>Watson, J.</td>
<td>(O–4418b–01)</td>
</tr>
<tr>
<td>Watson Laura</td>
<td>(O–2205–03)</td>
</tr>
<tr>
<td>Author Name</td>
<td>Code(s)</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>Watts Nicholas</td>
<td>P-3321-17</td>
</tr>
<tr>
<td>Weaver, James C</td>
<td>O-2207-02</td>
</tr>
<tr>
<td>Webb Bob</td>
<td>O-4415b-01</td>
</tr>
<tr>
<td>Wehbe Monica B (P-4414-21)</td>
<td>P-2239-11</td>
</tr>
<tr>
<td>Weiberg Erika (O-2241-05)</td>
<td></td>
</tr>
<tr>
<td>Weigel Hans Joachim (O-2223-02)</td>
<td></td>
</tr>
<tr>
<td>Weiland Sabine (K-3313-03)</td>
<td></td>
</tr>
<tr>
<td>Weindl Isabelle (P-2217-13)</td>
<td>P-2219-13, P-2218-06</td>
</tr>
<tr>
<td>Weishaar Stefan (O-4420a-04)</td>
<td></td>
</tr>
<tr>
<td>Weisheimer Antje (O-1118a-02)</td>
<td></td>
</tr>
<tr>
<td>Weissenberger Sebastian (P-2243-14)</td>
<td></td>
</tr>
<tr>
<td>Wei Taoyuan (P-2224-06)</td>
<td></td>
</tr>
<tr>
<td>Weitzel Matthias (P-4418-17)</td>
<td>P-2217-26</td>
</tr>
<tr>
<td>Wei Xie (O-3309-02)</td>
<td></td>
</tr>
<tr>
<td>Weldesmaet Yitbarek Tibebe (P-2220-04)</td>
<td></td>
</tr>
<tr>
<td>Welle, Torsten (O-2203-02)</td>
<td>P-2204-15, P-2236-09</td>
</tr>
<tr>
<td>Wellman Jacob (P-4409-38)</td>
<td></td>
</tr>
<tr>
<td>Welsch, Julia (P-3303-02)</td>
<td></td>
</tr>
<tr>
<td>Welten, Kees (O-1103-02)</td>
<td></td>
</tr>
<tr>
<td>Wenz Leonie (P-2204-16)</td>
<td>O-2237a-03</td>
</tr>
<tr>
<td>Weschke Marius Sandvoll (P-1123-12)</td>
<td></td>
</tr>
<tr>
<td>Weyant John (K-3302-01)</td>
<td></td>
</tr>
<tr>
<td>Wheatamix Consortium The (P-2224-07)</td>
<td></td>
</tr>
<tr>
<td>Whippy-Morris Cherie (P-1105-05)</td>
<td></td>
</tr>
<tr>
<td>Whiteman, Gail (O-3327-03)</td>
<td></td>
</tr>
<tr>
<td>Whitmarsh Lorraine (O-3316-05)</td>
<td>O-2240-01</td>
</tr>
<tr>
<td>Wichmann Janine (P-3330-81)</td>
<td></td>
</tr>
<tr>
<td>Wickland, Kimberly P (P-1116-14)</td>
<td></td>
</tr>
<tr>
<td>Widerberg Oscar (O-4410-01)</td>
<td></td>
</tr>
<tr>
<td>Widforss Sofia (O-2212b-04)</td>
<td></td>
</tr>
<tr>
<td>Wiederhold Helga (O-2212a-03)</td>
<td></td>
</tr>
<tr>
<td>Wiener Jonathan (K-4420b-02)</td>
<td>P-4420-03</td>
</tr>
<tr>
<td>Wiwing, Mark (P-3337-01)</td>
<td></td>
</tr>
<tr>
<td>Wiertz, Thilo (P-3301-02)</td>
<td></td>
</tr>
<tr>
<td>Wierszeski Sophie (K-2218-03)</td>
<td></td>
</tr>
<tr>
<td>Wiesmuth Michael (P-3303-02)</td>
<td></td>
</tr>
<tr>
<td>Wijaya, Arief (P-2219-05)</td>
<td></td>
</tr>
<tr>
<td>Wikramanayake Eric (P-2214-01)</td>
<td></td>
</tr>
<tr>
<td>Wilcox, Eric (O-1116-03)</td>
<td></td>
</tr>
<tr>
<td>Wildenborg Ton (K-3307-02)</td>
<td></td>
</tr>
<tr>
<td>Wild Martin (O-1117-04)</td>
<td></td>
</tr>
<tr>
<td>Wiles Gregory (P-1101-05)</td>
<td></td>
</tr>
<tr>
<td>Wilfried Lütkenhorst (K-4410-02)</td>
<td></td>
</tr>
<tr>
<td>Wilkins Gill (P-4418-13)</td>
<td></td>
</tr>
<tr>
<td>Wilkinson Jeremy (O-3327-03)</td>
<td></td>
</tr>
<tr>
<td>Wilkinson Paul (O-2226-05)</td>
<td></td>
</tr>
<tr>
<td>Williams, Jim H (P-4402-15)</td>
<td>P-2218-07</td>
</tr>
<tr>
<td>Williams, S. (O-4418b-01)</td>
<td></td>
</tr>
<tr>
<td>Williams, Sian (O-1116-16)</td>
<td></td>
</tr>
<tr>
<td>Williams Mathew (O-1116-02)</td>
<td></td>
</tr>
<tr>
<td>William Solecki (P-2233-07)</td>
<td></td>
</tr>
<tr>
<td>Williamson Mark (P-2203-04)</td>
<td></td>
</tr>
<tr>
<td>Williamson Phillip (O-2207-05)</td>
<td>P-2207-04</td>
</tr>
<tr>
<td>Willis Zdenka (P-2207-04)</td>
<td></td>
</tr>
<tr>
<td>Willmot, Elena (O-1116-03)</td>
<td></td>
</tr>
<tr>
<td>Willner Sven (O-2237a-03)</td>
<td></td>
</tr>
<tr>
<td>Wills William (P-2218-08, O-4411-05)</td>
<td></td>
</tr>
<tr>
<td>Wilson Cabral De Sousa Jr (O-2243-04)</td>
<td></td>
</tr>
<tr>
<td>Wiltshire Andy (P-2204-10, P-2217-07, P-2218-09, P-2217-23)</td>
<td></td>
</tr>
<tr>
<td>Wing, Ian (P-3321-03)</td>
<td></td>
</tr>
<tr>
<td>Wing Ian (P-2223-14)</td>
<td></td>
</tr>
<tr>
<td>Winkelmann (K-L2.4-04)</td>
<td></td>
</tr>
<tr>
<td>Winkler Harald (O-3322a-04, P-4402-16)</td>
<td></td>
</tr>
<tr>
<td>Winkler Matthias (O-2231-01, P-2231-01, O-2231-10)</td>
<td></td>
</tr>
<tr>
<td>Winne Sarah (P-4418-13)</td>
<td></td>
</tr>
<tr>
<td>Name</td>
<td>Code</td>
</tr>
<tr>
<td>-----------------------</td>
<td>--------</td>
</tr>
<tr>
<td>Wylie Patrick</td>
<td>O-3305-05</td>
</tr>
<tr>
<td>Wyns Tomas</td>
<td>O-3305-05</td>
</tr>
<tr>
<td>Wyser Klaus</td>
<td>P-2204-14</td>
</tr>
<tr>
<td>Xavier Alexandre</td>
<td>P-2218-08</td>
</tr>
<tr>
<td>Xia Haibin</td>
<td>P-2205-10</td>
</tr>
<tr>
<td>Xia Lili</td>
<td>P-2223-22</td>
</tr>
<tr>
<td>Xiao-Jun Guo</td>
<td>O-2205-02</td>
</tr>
<tr>
<td>Xie Jun</td>
<td>P-3303-12</td>
</tr>
<tr>
<td>Xiong Ling</td>
<td>O-4420-02</td>
</tr>
<tr>
<td>Xoplaki Elena</td>
<td>P-1113-06, P-1113-23, P-3326-05, K-3326-02, O-2241-05</td>
</tr>
<tr>
<td>Xu Baiqing</td>
<td>O-1102-06</td>
</tr>
<tr>
<td>Xueref-Remy Irène</td>
<td>P-1115-15</td>
</tr>
<tr>
<td>Xue Yongkang</td>
<td>K-3330a-03</td>
</tr>
<tr>
<td>Xu Fei</td>
<td>P-3322-12</td>
</tr>
<tr>
<td>Xu Jianchu</td>
<td>O-3332-02</td>
</tr>
<tr>
<td>Yabi Ibouraïma</td>
<td>P-1117-50</td>
</tr>
<tr>
<td>Yadav Shobha Kumari</td>
<td>P-2244-06</td>
</tr>
<tr>
<td>Yadghar Amir M.</td>
<td>P-4418-32</td>
</tr>
<tr>
<td>Yadu Pokhrel</td>
<td>P-2202-05</td>
</tr>
<tr>
<td>Yagi Ekou</td>
<td>P-2240-15</td>
</tr>
<tr>
<td>Yahia Hussein</td>
<td>O-1115-04</td>
</tr>
<tr>
<td>Yamagata Yoshiki</td>
<td>P-2202-02, P-3307-07</td>
</tr>
<tr>
<td>Yamamoto Akitomo</td>
<td>P-2204-17</td>
</tr>
<tr>
<td>Yamanouchi Yasunori</td>
<td>P-2240-15</td>
</tr>
<tr>
<td>Yameng Qin</td>
<td>O-3303-04</td>
</tr>
<tr>
<td>Yang, Jia</td>
<td>P-1114-11</td>
</tr>
<tr>
<td>Yang Hong</td>
<td>P-2223-07</td>
</tr>
<tr>
<td>Yang Ling</td>
<td>P-2217-31</td>
</tr>
<tr>
<td>Yang Xiaoxin</td>
<td>O-1102-06</td>
</tr>
<tr>
<td>Yang Xin</td>
<td>P-1108-02</td>
</tr>
<tr>
<td>Author</td>
<td>Code</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>Yang Yanzhao</td>
<td>P-2217-31</td>
</tr>
<tr>
<td>Yang Zili</td>
<td>P-4409-21</td>
</tr>
<tr>
<td>Yan Huimin</td>
<td>P-2214-19</td>
</tr>
<tr>
<td>Yan Shuang</td>
<td>P-1116-18</td>
</tr>
<tr>
<td>Yao Etienne Kouakou</td>
<td>P-3328-19</td>
</tr>
<tr>
<td>Yao Guy Ferdinand</td>
<td>P-3330-20</td>
</tr>
<tr>
<td>Yao Ping</td>
<td>O-1102-06</td>
</tr>
<tr>
<td>Yao Tandong</td>
<td>O-1102-06</td>
</tr>
<tr>
<td>Yarime Masaru</td>
<td>P-3315-15</td>
</tr>
<tr>
<td>Yarmey Lynn</td>
<td>O-1105b-06</td>
</tr>
<tr>
<td>Yasushi Kiyoki</td>
<td>P-1104-01</td>
</tr>
<tr>
<td>Yatco Kevin Matthew</td>
<td>P2209-07</td>
</tr>
<tr>
<td>Yeboah Obeng Albert</td>
<td>O-3328-01</td>
</tr>
<tr>
<td>Yeboah Edward</td>
<td>O-2235-05</td>
</tr>
<tr>
<td>Yeemin Thamasak</td>
<td>P-2243-16</td>
</tr>
<tr>
<td>Ye Qian</td>
<td>O-3324-03</td>
</tr>
<tr>
<td>Yermolenko Natalia</td>
<td>P-1118-05</td>
</tr>
<tr>
<td>Yiou Pascal</td>
<td>O-1118a-02, P-1118-04, K-L1.1-02</td>
</tr>
<tr>
<td>Yniguez Aletta</td>
<td>P2209-07</td>
</tr>
<tr>
<td>Yohann Fare</td>
<td>P-2217-28</td>
</tr>
<tr>
<td>Yokohata Tokuta</td>
<td>P-2204-17, P-3307-07</td>
</tr>
<tr>
<td>Yokota, Tatsuya</td>
<td>K-1115-01</td>
</tr>
<tr>
<td>Yong Luo</td>
<td>O-2205-02</td>
</tr>
<tr>
<td>Yoon Jin-Ho</td>
<td>P-1113-22</td>
</tr>
<tr>
<td>Yoroba Fidèle</td>
<td>P-3330-09, P-1117-51</td>
</tr>
<tr>
<td>Yoro G. R.</td>
<td>P-3330-20</td>
</tr>
<tr>
<td>Yoseph–Paulus Rahayu</td>
<td>P-3312-24, P-2243-17</td>
</tr>
<tr>
<td>Yoshida Yukio</td>
<td>K-1115-01</td>
</tr>
<tr>
<td>Yoshimori Masakazu</td>
<td>P-2204-17</td>
</tr>
<tr>
<td>Yoshimura Kei</td>
<td>P-2202-05</td>
</tr>
<tr>
<td>Young, B.</td>
<td>O-4418b-01</td>
</tr>
<tr>
<td>Youngman Robert</td>
<td>P-4404-01</td>
</tr>
<tr>
<td>Young Nicolas</td>
<td>P-1101-05</td>
</tr>
<tr>
<td>Yowargana, Ping</td>
<td>P-3307-02</td>
</tr>
<tr>
<td>Yu, Jingshan</td>
<td>P-2212b-13</td>
</tr>
<tr>
<td>Yu, Yongqiang</td>
<td>P-1117-45, O-1122-03</td>
</tr>
<tr>
<td>Yuan Xing</td>
<td>O-1119a-02</td>
</tr>
<tr>
<td>Yue, Yun</td>
<td>O-1116-03</td>
</tr>
<tr>
<td>Yue Chao</td>
<td>O-2217-02</td>
</tr>
<tr>
<td>Yue Chen</td>
<td>P-3322-12</td>
</tr>
<tr>
<td>Yue Qun</td>
<td>P-3322-12</td>
</tr>
<tr>
<td>Yulinaawi Hernani</td>
<td>O-3318-03</td>
</tr>
<tr>
<td>Yumashev Dmitry</td>
<td>O-3327-03</td>
</tr>
<tr>
<td>Yung Esther Hiu–Kwan</td>
<td>O-2231-04</td>
</tr>
<tr>
<td>Yu Sha</td>
<td>O-3305-02</td>
</tr>
<tr>
<td>Yusuf Subhan Ali</td>
<td>P-3315-16</td>
</tr>
<tr>
<td>Yver-Kwok, Camille</td>
<td>P-1115-12, P-1105-14</td>
</tr>
<tr>
<td>Zaaboul, R</td>
<td>O-1118b-05</td>
</tr>
<tr>
<td>Zabalza–Martínez, J.</td>
<td>P-1119-19</td>
</tr>
<tr>
<td>Zafrilla Jorge</td>
<td>P-4409-05</td>
</tr>
<tr>
<td>Zaharias, Paul</td>
<td>P-3330-13</td>
</tr>
<tr>
<td>Zaherpour Jamal</td>
<td>P-2205-11</td>
</tr>
<tr>
<td>Zahn Andreas</td>
<td>P-1105-19</td>
</tr>
<tr>
<td>Zakari Soufyane</td>
<td>P-1117-50</td>
</tr>
<tr>
<td>Zalpyte Jolanta</td>
<td>O-4411-02, P-4413-06</td>
</tr>
<tr>
<td>Zamorschchikova Liudmila</td>
<td>P-2238-09</td>
</tr>
<tr>
<td>Zampieri, Matteo</td>
<td>O-1113-06</td>
</tr>
<tr>
<td>Zanchettin Davide</td>
<td>O-1103-05</td>
</tr>
<tr>
<td>Zanette Lorenzo R.s.</td>
<td>O-2222-02</td>
</tr>
<tr>
<td>Zare Aida</td>
<td>P-3330-82</td>
</tr>
<tr>
<td>Zarka Yves Charles</td>
<td>K-4410-01</td>
</tr>
<tr>
<td>Zaroug Modathir</td>
<td>P-2222-11</td>
</tr>
<tr>
<td>Zawadzki, Lionel</td>
<td>P-1107-02</td>
</tr>
<tr>
<td>Zazulie Natalia</td>
<td>P-2212a-22</td>
</tr>
<tr>
<td>Zebaze Sinclair</td>
<td>P-3330-83</td>
</tr>
<tr>
<td>Authors</td>
<td>Codes</td>
</tr>
<tr>
<td>-----------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>Ziervogel Gina</td>
<td>K-L4.4-04, P-3312-06, O-4407-01, K-3328-01</td>
</tr>
<tr>
<td>Zin Isabella</td>
<td>O-2211-05</td>
</tr>
<tr>
<td>Ziveri Patrizia</td>
<td>P-2207-03, K-3326-03</td>
</tr>
<tr>
<td>Zoli Mariangela</td>
<td>P-4409-08</td>
</tr>
<tr>
<td>Zomer Robert</td>
<td>K-3332-01</td>
</tr>
<tr>
<td>Zommers Zinta</td>
<td>P-4418-29, P-2234-05</td>
</tr>
<tr>
<td>Zong-Ci Zhao</td>
<td>O-2205-02</td>
</tr>
<tr>
<td>Zongo Betoe</td>
<td>P-4414-22, P-2222-13</td>
</tr>
<tr>
<td>Zorita Eduardo</td>
<td>K-3326-02</td>
</tr>
<tr>
<td>Zougmore, François</td>
<td>P-3330-34</td>
</tr>
<tr>
<td>Zougmore Robert</td>
<td>K-3330b-03</td>
</tr>
<tr>
<td>Zuber Stéphane</td>
<td>P-4412-05</td>
</tr>
<tr>
<td>Zulkaflı, Zed</td>
<td>O-2212b-01</td>
</tr>
<tr>
<td>Zunino, Patricia</td>
<td>O-1110-04</td>
</tr>
<tr>
<td>Zusman Eric</td>
<td>P-3318-02</td>
</tr>
<tr>
<td>Zverinova, Iva</td>
<td>P-4409-03</td>
</tr>
<tr>
<td>Zwiers Francis</td>
<td>K-1118a-01</td>
</tr>
<tr>
<td>Ziervogel Gina</td>
<td>K-L4.4-04, P-3312-06, O-4407-01, K-3328-01</td>
</tr>
<tr>
<td>Zin Isabella</td>
<td>O-2211-05</td>
</tr>
<tr>
<td>Ziveri Patrizia</td>
<td>P-2207-03, K-3326-03</td>
</tr>
<tr>
<td>Zoli Mariangela</td>
<td>P-4409-08</td>
</tr>
<tr>
<td>Zomer Robert</td>
<td>K-3332-01</td>
</tr>
<tr>
<td>Zommers Zinta</td>
<td>P-4418-29, P-2234-05</td>
</tr>
<tr>
<td>Zong-Ci Zhao</td>
<td>O-2205-02</td>
</tr>
<tr>
<td>Zongo Betoe</td>
<td>P-4414-22, P-2222-13</td>
</tr>
<tr>
<td>Zorita Eduardo</td>
<td>K-3326-02</td>
</tr>
<tr>
<td>Zougmore, François</td>
<td>P-3330-34</td>
</tr>
<tr>
<td>Zougmore Robert</td>
<td>K-3330b-03</td>
</tr>
<tr>
<td>Zuber Stéphane</td>
<td>P-4412-05</td>
</tr>
<tr>
<td>Zulkaflı, Zed</td>
<td>O-2212b-01</td>
</tr>
<tr>
<td>Zunino, Patricia</td>
<td>O-1110-04</td>
</tr>
<tr>
<td>Zusman Eric</td>
<td>P-3318-02</td>
</tr>
<tr>
<td>Zverinova, Iva</td>
<td>P-4409-03</td>
</tr>
<tr>
<td>Zwiers Francis</td>
<td>K-1118a-01</td>
</tr>
</tbody>
</table>